INVESTIGATIONS ON FISH AND FISHERIES OF COCHIN BACKWATERS IN AND AROUND SOUTHWEST MONSOON PERIOD

DISSERTATION SUBMITTED BY

Miss PREETHA K.

IN PARTIAL FULFILMENT FOR THE DEGREE OF
MASTER OF SCIENCE (MARICULTURE)
OF THE
COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

OCTOBER 1987

POST-GRADUATE EDUCATION AND RESEARCH PROGRAMME
IN MARICULTURE

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
COCHIN - 682 031

CERTIFICATE

This is to certify that this Dissertation is a bonafide record of the work done by Kum. Preetha, K. under my supervision and that no part thereof has been presented before for any other degree.

Dr. A. Noble,
Scientist S - 3,
Central Marine Fisheries
Research Institute,
Cochin - 31.

Countersigned by

Dr. P. S. B. R. James,
Director,
Central Marine Fisheries
Research Institute,
Cochin - 31.

CONTENTS

		Page No.
1.	Preface	1
2.	Introduction	3
3.	Material and methods	9
4.	Results	
	4.1. Species of fish caught	13
	4.2. Catch - Centrewise	13
	4.3. Cast net operation	18
	4.4. Experimental fishing	19
	4.5. Finfish catch - Specieswise	19
	4.6. Length frequency	36
	4.7. Length-weight relationship	40
	4.8. Sex ratio	45
	4.9. Stomach content	46
5.	Discussion	49
6.	Summary	66
7.	References	69

.....

P R E F A C E

The fisheries sector has been accorded an important role in India's economic development plans. With the restrictions in the areas of exploitations of the marine fisheries by declaration of the Exclusive Economic Zone, and the need for meeting additional supplies of fish and earnings of foreign exchange, most of the countries have directed their attention and interests to brackishwater fish farming. India's potential brackishwater area for culture, based on various estimates is about 9 lakh ha of which the present utilization is a meagre 2.91%.

Brackishwater fields in the low lying areas adjoining the backwater system in Cochin are being used for the culture of finfishes and shellfishes for the past so many centuries. At present over 5,000 ha of these brackishwater fields are under cultivation. A variety of fishes such as Etroplus sp., Mugil sp. and Sorotherodon sp.and penaeid prawns namely Penaeus indicus, P. monodon, Metapenaeus dobsoni, M. affinis and M. monoceros are cultured in these fields. The Cochin Backwaters, which forms the northern part of the vast Vembanad Lake, serves as a feeder canal to these culture ponds.

A perusal of the literature reveals that several studies have been conducted on the hydrography, the species

composition, ecology, productivity, etc. of the Cochin Backwaters. But studies on the fishery of this region and the species-wise catch are limited. However, in the context of rapidly developing coastal aquaculture in the country and considering the importance of the various fishes/ prawns in sustaining the yield and their significance in culture operations, the present investigation on the fish and fisheries of Cochin Backwaters was taken up.

I wish to express my deepest sense of gratitude to my guide Dr. A. Noble, Scientist S-3, Central Marine Fisheries Research Institute for his valuable guidance and constant encouragement throughout the study and preparation of dissertation. I am greatly indebted to Dr. P.S.B.R. James, Director of this Institute for envincing keen interest and for the excellent facilities accorded to carry out this investigation. My thanks are due to Dr. Scariah, Scientist S-2, Central Marine Fisheries Research Institute for helping me through the statistical analyses of the data. My thanks are due to Shri M.A. Nizar, Technical Assistant, CMFRI for helping me in the identification of fishes. I express my sincere gratitude to the Indian Council of Agricultural Research for awarding me a Junior Research Fellowship during the tenure of which this investigation was carried out.

I N T R O D U C T I O N

India has a coastline of 6090 km and about 2.5 million ha of backwaters lying adjacent to it. Though many of these backwaters are being used for fishing and transportation, only very few are scientifically managed. In recent years, however, studies on these backwater systems are gaining special attention.

Cochin Backwater is a system of shallow brackishwater area in the Vembanad Lake that extends from Crangannore in the north to Alleppey in the south in Kerala State. It covers a stretch of 256 km (Shetty, 1963) and is deeper in the harbour area close to the sea, the depth being about 12 m; and shallower in the upper reaches with a depth of about 1.5 m. A channel of 500 m width at Cochin gut, makes a permanent connection of it with the Arabian Sea and transmits the tidal energy and seawater into the lake.

The major sources of freshwater emptying into the Cochin backwaters are 2 large rivers, Periyar in the north, and Pampa which flows into the Vembanad Lake in the south. Another river, Moovattupuzha with its tributary Ithipuzha also joins the lake about mid way between Cochin and Alleppey. Three other small rivers namely, Achankoil, Manimala and Meenachil also flow into the lake. These rivers discharge

large quantities of freshwater into the estuary during the south-west and north-east monsoons. During monsoon the backwater receives an average rainfall of 3300 mm, virtually converting the estuary into a freshwater basin.

Tides of the Cochin region are of mixed semidiurnal type and 2 successive high and low water appear each day, with an average height of about 90 cm. The discharge of freshwater from various rivers and drainage canals and the inflow of seawater into the backwater bring about dynamic conditions which make the backwater extremely interesting and ecologically an intriguing environment.

Cochin Backwater supports a general subsistance fishery to a large number of fishermen families depending on it. The backwater is popular for the stake nets and Chinese dip nets fishing for commercially important penaeid prawns such as Metapenaeus dobsoni, M. affinis, M. monoceros and Penaeus indicus and fishes like mullets, pearl spot, milk fish, etc. Cast nets, gill nets, drift nets and drag nets are also extensively being used for fishing in the area.

The extended arms of Cochin Backwaters form excellent sites for culture of prawns and fishes. A number of such water enclaves are used as seasonal and perennial culture ponds from time immemorial. The paddy-cum-prawn culture practised in Vypeen Island is well known for centuries. In

these traditional systems fish and prawns let into the fields during high tide are allowed to grow there before they are filtered out during 'thakkom' at low tides.

In recent years, for augmenting fish production, selective stocking and scientific culture have been receiving increasing attention. In this, seeds collected from the wild are sorted out according to choice and stocked. The Cochin Backwater well known for its role as a nursery ground for many of the commercial species suitable for culture serves as a natural seed bank from where the postlarvae and juveniles of desired ones are caught for culture. But large scale fishing operations that take place in the backwater, inadvertently cause extensive destruction of the fish and prawns when they are undersized and uneconomical. Also exploitation of seed of a selected species for stocking incidently results in heavy damage not only to it but also to the discarded seeds of other species that co-exist with it and thus reduces the fishery potential.

The pollution problems prevalent in the backwaters also inhibit the success of fishery in the area. Cochin is the industrial city of Kerala State. Large concerns like the FACT, TCC, HIL, Rare Earths, Periyar Chemicals, Industrial Estates, Shipyard, Oil tanker berths, etc. located in and around Cochin pollute the backwaters with their effluents. In the upper

reaches of the backwater lie extensive coir industry causing serious problems of pollution. The factories like Vellore Paper Mills, Nattakom Cement Factory, Electro Chemicals India at Pallom, etc. situated on the banks of Vembanad Lake also change the ecosystem contaminating the fish and prawns with pollutants and heavy metals. The organic discharges from the Paper Mill and the seafood processing units and the coir retting interfere with the food chain at various trophic levels by increasing the BOD and consequent depletion of oxygen in the water ultimately leading to reduction in the fishery resources. The dissolved and suspended organic constituents of the Municipal and domestic sewage could increase the productivity of the environment. But on excessive accumulation they cause oxygen depletion and other unfavourable conditions to aquatic life.

Added to this, the heavy run-off of freshwater washing down tonnes and tonnes of insecticides and pesticides sprayed in the vast stretches of plantations, situated in the catchment area from where the feeder rivers originate and also the prolific use of these chemicals to save the paddy cultivation in Kuttanad, which is the granary of Kerala cause intense pollution problems which go against the flourishing of fauna supporting the fishery. Theaquatic weeds like Salvinia molesta and Eicchornia sp. also can interfere with the biolo-

gical life and distribution of the fauna.

Another problem that continues to threaten the fishery is the heavy siltation caused by the periodic dredging that goes on in the harbour and shipping channel (Gopinath and Qasim, 1971). Similarly, the large scale reclamation programmes of backwaters for purposes of agriculture, housing, etc. not only reduce the total area of the shrimp and fish culture fields and nursery grounds but also considerably alter the physical features like tidal flow, water circulation and current which are congenial for the prawns and fishes. The Thanneermukkom bund in the Vembanad lake, constructed in 1976, has altered the entire physico-chemical conditions of the ecosystem adversely affecting the distribution, abundance and proliferation of the giant freshwater prawn Macrobrachium rosenbergii.

A knowledge on the physico-chemical characteristics of an ecosystem is a prerequisite to develop it into a suitable culture system. With regard to Cochin Backwaters a number of investigations on its hydrography have already been carried out by various workers like Balakrishnan (1957), George and Kartha (1963), Ramamirtham and Jaya Raman (1963), Cheriyan (1967), Qasim and Gopinathan (1969), Josanto (1971), Nair and Tranter (1971), Haridas et al. (1973), Kuttyamma (1975), Sreedharan and Salih

(1974), Ramamirtham and Muthuswami (1986), and Ramamirtham et al. (1986)

Similarly on the biology, considerable work has been done on the prawn resources of Cochin Backwaters (George 1961 and 1963, Mohamed and Rao, 1971, Silas et al. 1981, and Suseelan and Kathirvel, 1982). Pillai (1973) has worked on the larval development and rearing of the backwater shrimp Leptocarpus, whose juveniles and postlarvae are found abundantly in the Cochin area. The Vembanad Lake is famous for its lime shell resources. Systematic survey on lime shell deposits and clam resources has been conducted by Rasalam and Sebastian (1976).

The fishery and biology of commercially important fishes in the backwaters were studied by Shetty (1963, 1965); Samuel (1969); and recently by Kurup (1982). The estimated total landings of prawns and fishes of Cochin Backwaters in 1965-66 according to Samuel (1969) was 1252 tonnes.

Although a thorough knowledge on the biology and fisheries of the species of fish is necessary for its management in either capture or culture, information available on the fish and fishery of Cochin Backwaters on the whole in the literature is limited. Under this circumstance it was considered more opportune to take up a fresh study of the fishery in this backwaters and to investigate on the biology of important contributing species of finfishes on which this dissertation is made.

MATERIAL AND METHODS

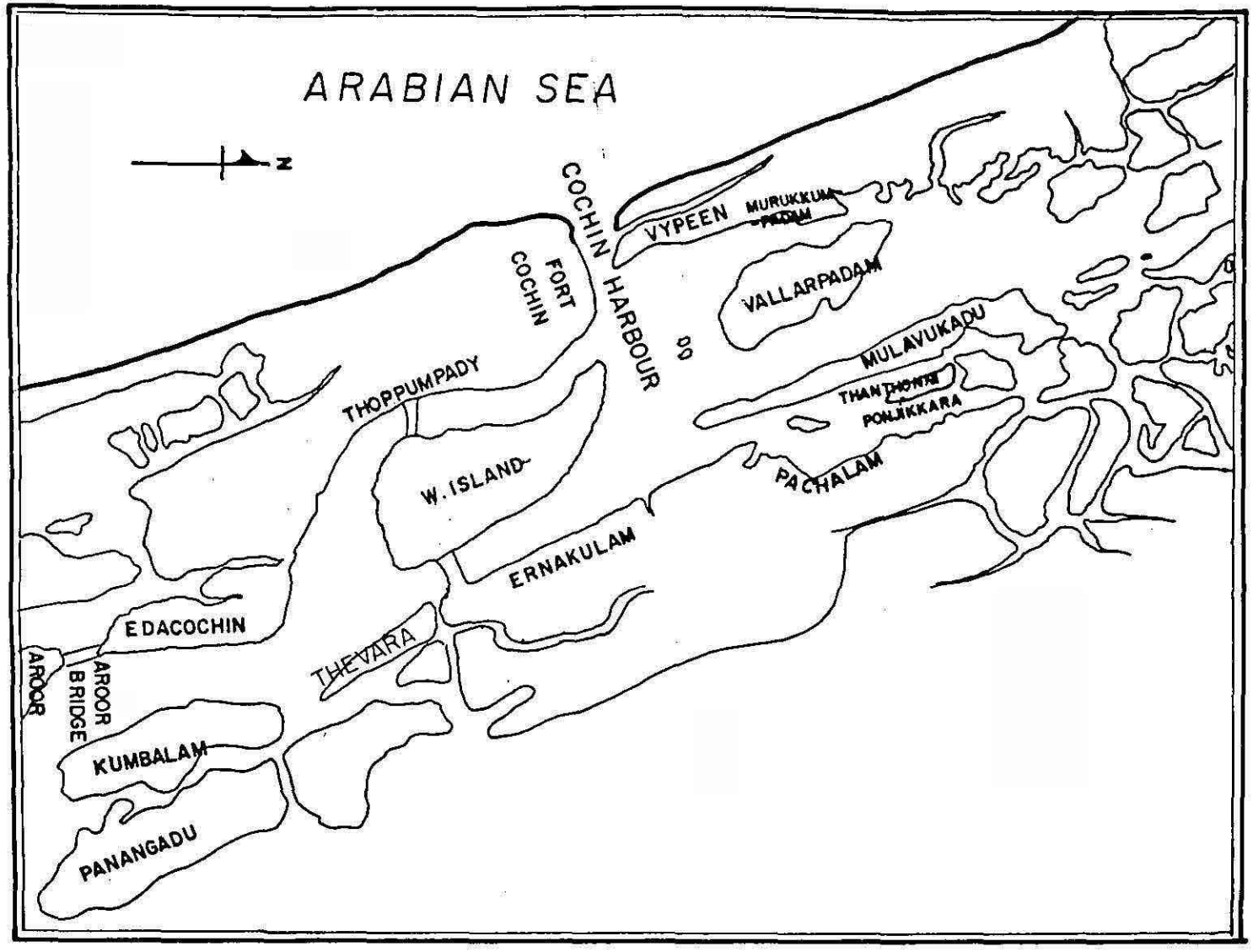
Weekly observations on the fish landings at 5 centres selected randomly, viz. Pachalam and Vypeen in the northern sector and Fort Cochin, Thoppumpady and Thevara in the southern sector in the Cochin Backwaters (Fig. 1) were made. Commercial fishing by cast nets in the backwaters and experimental trawling conducted in the shipping channel from R.V. Cadalmin were also studied for the species composition.

The gears operated in the backwaters are stake nets (oonni vala), dip net (cheena vala), drag net (koru vala), drift net (ozhukku vala) and cast net (veechu vala). Informations on the mesh size of these nets were collected for relating it to the size of the fish caught.

Samples of fish landed by the different gears at these centres were taken at random for laboratory biological investigation. As far as possible the fishes were identified upto the species level.

In the laboratory the total length of each fish in millimetre was measured by placing it on a board with the mouth closed and the snout pressed gently against the headpiece and the caudal lobe flexed in line with snout. The wet weight of each fish in gram was taken either on an electronic balance or physical balance, depending on the size of the fish.

Fig: 1. Study Area


ARABIAN SEA
N
COCHIN HARBOUR
VYPEEN
MURUKKUM PADAM
FORT COCHIN
VALLARPADAM
MULAVUKADU
THANTHONI PONJIKKARA
THOPPUMPADY
W. ISLAND
PACHALAM
ERNAKULAM
EDACOCHIN
THEVARA
AROOR
AROOR BRIDGE
KUMBALAM
PANANGADU

The gut contents of the sampled fish were studied for qualitative relative abundance under a binocular microscope. The sex of each fish sampled was recorded for determining the sex ratio in the catches.

The landings were estimated on a daily basis by random sampling and then summed up for every month. Usually 10-20% of the total number of units operated in each type was sampled. The daily total catch (Y_d) in respect of each type of unit was estimated as

$$Y_d = \frac{U}{n} \sum_{i=1}^{n} Y_i$$

where Y_i = the catch of i^{th} unit

U = the total number of units operated

and n = the number of units observed.

The monthly catch (Y_m) was then estimated by the formula

$$Y_m = \frac{D}{d} \sum_{i=1}^{d} Y_d$$

where D = total number of fishing days in a month

d = number of observation days

The length-weight relationship was calculated using the formula,

$$\log W = a + b \log L$$

where W = weight of the fish in gram

L = length of the fish in millimetre

a = a constant

and b = the regression slope

The 'a' and 'b' of the equation can be calculated using the formula,

$$b = \frac{\Sigma XY - \frac{\Sigma X \, \Sigma Y}{N}}{\Sigma X^2 - \frac{(\Sigma X)^2}{N}}$$

and $$a = \frac{\Sigma Y}{N} - b \left(\frac{\Sigma X}{N}\right)$$

where N = number of observations.

The correlation between length and weight was found out using the formula,

$$r = \frac{\Sigma XY - \frac{\Sigma X \, \Sigma Y}{N}}{\sqrt{\Sigma X^2 - \left(\frac{\Sigma X}{N}\right)^2 \quad \Sigma Y^2 - \left(\frac{\Sigma Y}{N}\right)^2}}$$

The length-weight relationship of the males and females of each species of fish was compared using F-test (Snedecor and Cochran, 1967).

In the F test, the sum of squares (s.s.) was calculated as follows:

$$s.s. = \Sigma y^2 - \frac{(\Sigma xy)^2}{x^2}$$

where

$$\Sigma y^2 = Y^2 - \frac{(\Sigma Y)^2}{N}$$

$$\Sigma x^2 = X^2 - \frac{(\Sigma X)^2}{N}$$

and

$$\Sigma xy = \Sigma XY - \frac{\Sigma X \Sigma Y}{N}$$

The mean sum of squares (M.S.) was calculated as

$$M.S. = \frac{s.s.}{d.f.}$$

where

$$d.f. = N - 2$$

All the observations in the study are graphically represented in the text.

4. RESULTS

4.1. Species of fish caught in Cochin Backwater during the period of study

Penaeid prawns form the most important item in the backwater fishery at Cochin (Fig. 2 and 3). The common and dominant species among them is 'Thelly' (Metapenaeus dobsoni). 'Naran' (Penaeus indicus) is the next abundant form. 'Choodan' (Metapenaeus monoceros) also contributes to the fishery in a small way. Prawn like 'Kazhanthan' (M. affinis) is occasionally caught and 'Kara' (P. monodon) is found rarely. The Carridean prawn, Acetes indicus is caught in stake nets occasionally in abundant quantities.

In the present study, being intended to investigate the finfish resources, the landings of all these prawns are only collectivelly considered.

The fishes that occurred in the backwater during the observation are listed in Table 1 following the classification by Munro (1982). The species name, the popular English name and the vernacular are given in the table, indicating also the families and the genera involved.

4.2. Catch - Centrewise:

There are a number of fishing centres surrounding the Cochin Backwaters. They are; Edacochin, Aroor, Kumbalam,

Table 1

Species of fish caught in Cochin Backwater during the period of study

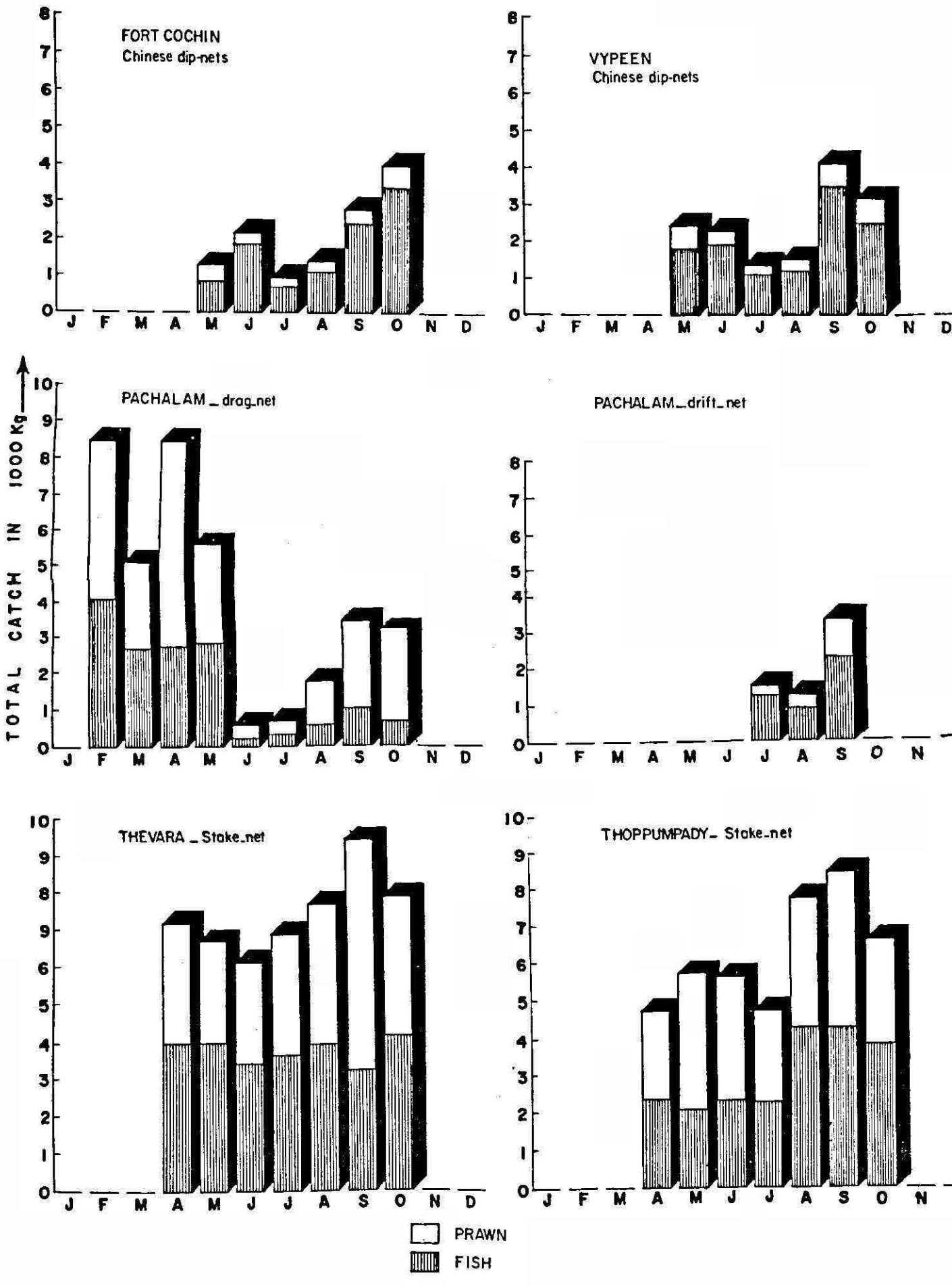
S.No.	Family	Genus	Species	Common English Name	Vernacular
1.	Elopidae	Elops	Elops saurus	Giant herring	Valli poomeen
2.	Megalopidae	Megalops	Megalops cyprinoides	Tarpon	Palankanni
3.	Clupeidae	Sardinella	Sardinella longiceps	Oil sardine	Chala, Mathi
4.	Clupeidae	Escualosa	Escualosa thoracata	White sardine	Veloory
5.	Clupeidae	Pellona	Pellona sp.	Shad	Kockan chala
6.	Dussumeiridae	Ehirava	Ehirava fluviatilis	Estuarine sprat	Soochi kozhuva
7.	Dorosomidae	Anadontostoma	Anadontostoma chacunda	Gizzard fish	Mangathodi
8.	Engraulidae	Stolephorus	Stolephorus commersonii	Anchovy	Kozhuva
9.	Engraulidae	Thryssa	Thryssa mystax	Mustached anchovy	Manangu
10.	Engraulidae	Thryssa	Thryssa setirostris	Long-jawed anchovy	Manangu
11.	Chanidae	Chanos	Chanos chanos	Milk fish	Poomeen
12.	Tachysuridae	Tachysurus	Tachysurus maculatus	Estuarine cat fish	Koori
13.	Anguillidae	Anguilla	Anguilla sp.	Eel	Mathiran
14.	Belonidae	Strongylura	Strongylura strongylura	Round-tail alligator gar	Kolan

15.	Hemiramphidae	Hemiramphus	Hemiramphus sp.	Half-beak	Kolan
16.	Holocentridae	Holocentrus	Holocentrus rubrum	Soldier fish	Katantha mulli
17.	Sphyraenidae	Sphyraena	Sphyraena sp.	Barracuda	Olakkameen
18.	Mugilidae	Mugil	Mugil cephalus	Mullet	Thirutha
19.	Mugilidae	Liza	Liza macrolepis	Mullet	Kanambu
20.	Mugilidae	Liza	Liza parsia	Gold spot mullet	Kanambu
21.	Mugilidae	Valamugil	Valamugil cunnesius	Mullet	-
22.	Polynemidae	Eleutheronema	Eleutheronema tetradactylum	Four-thread tassel fish	Vaazhumeen
23.	Latidae	Lates	Lates calcarifer	Cock-up giant perch	Kalanchi
24.	Ambassidae	Ambassis	Ambassis gymnocephalus	Glassy perchlet	Nandan
25.	Ambassidae	Ambassis	Ambassis dayi	Glassy perchlet	Aattu nandan
26.	Serranidae	Epinephelus	Epinephelus sp.	Grouper	Kalava
27.	Theraponidae	Eutherapon	Eutherapon theraps	Large-scaled banded grunter	Keeri
28.	Sillaginidae	Sillago	Sillago sihama	Indian whiting, Lady fish	Kathiran
29.	Lactaridae	Lactarius	Lactarius lactarius	White fish	Parava

30.	Carangidae	Caranx	Caranx malabaricus	Golden scad	Vatta
31.	Carangidae	Caranx	Caranx sexfasciatus	Six-banded trevally	Vatta
32.	Lutianidae	Lutianus	Lutianus argentimaculatus	Snapper	Chemballi
33.	Gerridae	Gerres	Gerres filamentosus	Long rayed silver biddy	Pranjil
34.	Gerridae	Gerres	Gerres oyena	Lined silver biddy	Pranjil
35.	Leiognathidae	Secutor	Secutor insidiator	Slender barred pony fish	Mullan
36.	Leiognathidae	Leiognathus	Leiognathus brevirostris	Short-nosed pony fish	Mullan
37.	Leiognathidae	Leiognathus	Leiognathus bindus	Orange finned pony fish	Mullan
38.	Leiognathidae	Leiognathus	Leiognathus daura	Golden-stripped pony fish	Mullan
39.	Leiognathidae	Leiognathus	Leiognathus equulus	Greater pony fish	Mullan
40.	Sciaenidae	Johnius	Johnius belangeri	Jew fish	Kuttan
41.	Sciaenidae	Johnius	Johnius carouna	Jew fish	Kuttan
42.	Scatophagidae	Scatophagus	Scatophagus argus	Spotted butterfish	-
43.	Cichlidae	Sorotherodon	Sorotherodon mossambica	Tilapia	Tilapia

44.	Cichlidae	Etroplus	Etroplus suratensis	Pearl spot	Karimeen
45.	Cichlidae	Etroplus	Etroplus maculatus	Spotted etroplus	Pallathi
46.	Siganidae	Siganus	Siganus oramin	Rabbit fish	Karadu meen
47.	Acanthuridae	Ctenochaetus	Ctenochaetus strigosus	Unicorn fish/ surgeon fish	-
48.	Trichiuroidae	Trichiurus	Trichiurus sp.	Ribbon fish	Pampada
49.	Scombridae	Rastrelliger	Rastrelliger kanagurta	Indian mackerel	Ayila
50.	Scomberomoridae	Cybium	Cybium guttatum	Barred spanish mackerel	Neimeen
51.	Stromatidae	Pampus	Pampus argenteus	Pomfrets	Akoli
52.	Trypauchenidae	Trypauchen	Trypauchen vagina	Burrowing goby	Thondi
53.	Platycephalidae	Platycephalus	Platycephalus crocodilus	Flat head	Uruthal
54.	Soleidae	Synaptura	Synaptura sp.	Flat fish	Nanku
55.	Cynoglossidae	Cynoglossus	Cynoglossus sp.	Flat fish	Nanku
56.	Triacanthidae	Triacanthus	Triacanthus sp.	Tripod fish	Klathi
57.	Tetradontidae	Tetradon	Tetradon sp.	Puffer fish	Pothal
58.	Batrachoididae	Austrobatrachus	Austrobatrachus dussumeiri	Frog fish	Thavala

Fig. 2. Total production at the different centres


FORT COCHIN
Chinese dip-nets
VYPEEN
Chinese dip-nets
PACHALAM _ drag_net
PACHALAM_drift_net
TOTAL CATCH IN 1000 Kg
THEVARA _ Stake_net
THOPPUMPADY_ Stake-net
J F M A M J J A S O N D
PRAWN
FISH

Panangad, Thevara, Thoppumpadi, Fort Cochin, Vypeen, Murukumpadom Mulavukadu, Ponjikara, Thanthonni and Pachalam (Fig. 1). There are hundreds of stake net units in installation especially at Edacochin, Aroor, Kumbalam and Panangad area. Dip nets, drag nets and drift nets are also widely being used. The present observation, being of a short duration, it was difficult to cover the entire backwater region. Centres located at the openings of the Cochin Backwater area in the arms feeding it and also at the bar mouth were selected randomly for sampling.

4.2.1. Fort Cochin (Fig. 1)

Observations at this centre were made for 6 months from May to October. The gear in operation at Fort Cochin is the Chinese dip net. There are 18 of these nets and they are operated during high tides when the currents are favourable. If any undercurrent persists during the high tide these nets can not be used.

The monthly landings (Fig. 2) here varied between 955 kg in July and 4001 kg in October. During the 6 months period under observation, it totalled 12,581 kg. In May and October the prawns in the landings amounted to 462 to 450 kg respectively. While this formed 36% of the total catch by the dip net in May, in October it formed only 11%. Out of the total for the 6 months under consideration only 17% is contributed by the prawns. The fishes thus form the important item in the catches of Chinese dip nets at Fort Cochin.

4.2.2. Vypeen (Fig. 1)

Chinese dip net is the gear used for fishing at Vypeen by the side of the bar mouth where the fish (12,137 kg) in the total catch (14,812 kg) for the 6 months under study (Fig. 2), accounted to 82%, the remaining 2,675 kg (18%) being prawns. The prawn landings at this Centre in May, September and October were 593, 547 and 688 kg respectively. Its catch was the lowest with 204 kg in July. In percentage it ranged between 13 in September and 25 in May.

There are 20 units of Chinese dip nets in installation at Vypeen bar mouth. The total production of fish including prawns (Fig. 2) here varied between 1,323 kg in July to 4,096 kg in September. The operations at Vypeen commences only about an hour after it starts at Fort Cochin.

4.2.3. Pachalam (Fig. 1)

Observations at Pachalam went on for a longer period of 9 months commencing from February. Drag net is the gear used for fishing at this centre. A total of 34 units are available here. It is a long wall net of around 20 m length and 2 m width. At both ends the net is tied to a 2 m long bamboo pole. The net is made up of synthetic material and knot to knot the mesh size is 0.6 mm. In operation, the net is dragged along in shallow water by 2 or 4 people wading through the water for about 50 m and then gathered together and the fish emptied into a 'thoni' (dug-out canoe) anchored in the vicinity. The fishermen work for 2 to 3 hours in the morning

hours and land the catch by 7 a.m. for disposal.

The total catch (Fig. 2) by this net ranged between 535 kg and 8,474 kg respectively in June and April. In the period between February and May, the catch was good. June and July were the lean months. From August onwards the catches again picked up.

The most important component in the catches of the drag net is the prawn. In percentage, in general, the prawns formed 50-70% of the total catch. The total landings by the drag net at Pachalam during the period under review was estimated to be 37,281 kg of which 20,432 kg (55%) were prawns and 16,849 kg (45%) fish. Exceptionally (Fig. 2) the fish formed 79% in October pushing the prawn catch down to 21%.

Drift nets from nearby places like Ponjikkara and Thanthonni (Fig.1) were also landed at Pachalam during July-September period. The number of units involved in this sector was 56. These nets are also made of synthetic material and has a knot to knot mesh size of around 2.5 to 4 cm. In length this net measures 25 m and its width is 1.5 m. Unlike the drag net this gear while in operation is allowed to drift according to the current.

The catches in this net will be of assorted sizes preferably bigger ones. In the 3 months the catch by this net totalled 6,033 kg. Of this, 1,651 kg forming 27% were prawns of bigger size namely, Penaeus indicus.

4.2.4. Thevara (Fig. 1)

The period of observation at Thevara extends from April to October. The gear used for fishing here is the stake net. There are 100 units in operation at this place.

The monthly total catch (Fig. 2) at Thevara was almost uniform with 6,114 kg and highest in September with 9,439 kg. The total catch for all the months put together amounted to 51,414 kg.

The fish in the catch at Thevara was also, so to say, steady from month to month showing a variation only between 3,211 and 4,133 kg in September and October respectively. The landings of prawns, however, were exhibiting a little bit of fluctuation. Out of the total landings; 25,582 kg forming 50% was prawns. While the prawns formed only 41% in May it contributed to 66% in September.

4.2.5. Thoppumpady (Fig. 1)

Thoppumpady is another centre in the Cochin Backwaters where 106 stake nets are used for fishing. Between April and October, when this study was conducted, the monthly catch by the stake nets here was estimated to range from 4,698 kg in July to 8,434 kg in September (Fig. 2). As is evident from Fig. 2 the catches were comparatively low during April - June as in the case of minimum observed in July. In August

there was a spurt in the landing leading to the peak in September followed by a little lowering in October. The finfish catches in the first 4 months of the observation period again was almost steady around 22 hundred kg, as it ranged only between 2,124 kg in May and 2,330 kg in April. In the following 2 months the fish catches stood at a level of 4,257 kg in August and 4,226 kg in September. In October, parallel to the fall in the total catch the finfish catch also dropped to 2,783 kg.

The finfish in the monthly catch varied between 37% in May and 55% in August. In the total catch of 43,583 kg for the 6 months under observation, it formed 20,229 kg contributing to 46% only. At Thoppumpady also the prawns thus formed the major constituent in stake nets contributing to 54% of the total catch. The prawn catch, however, varied in the landings between 2,388 kg in April and 4,208 kg in September. In percentage the variation, nevertheless was between 45 in August and 63 in May.

4.3. Cast net operations

Periodically in the open backwaters during 'Thakkom' at high tide a fleet of cast nets are observed to operate. These cast net operatiors are of a migrants type shifting in the entire backwater according to the tidal flow. About 60 units are observed to be engaged in this fishing. The important item caught by cast nets are is prawn, 'Thelly' fishes, mostly

Ambassis and others like Johnius spp. and Stolephorus sp. were also caught.

The catches by the cast nets are mostly used for personal consumption by the fishermen. As such they may not land their catch regularly at any one centre. In case the catches are good they dispose it off at places where high prices are quoted. As such, collection of catch statistics on them is difficult.

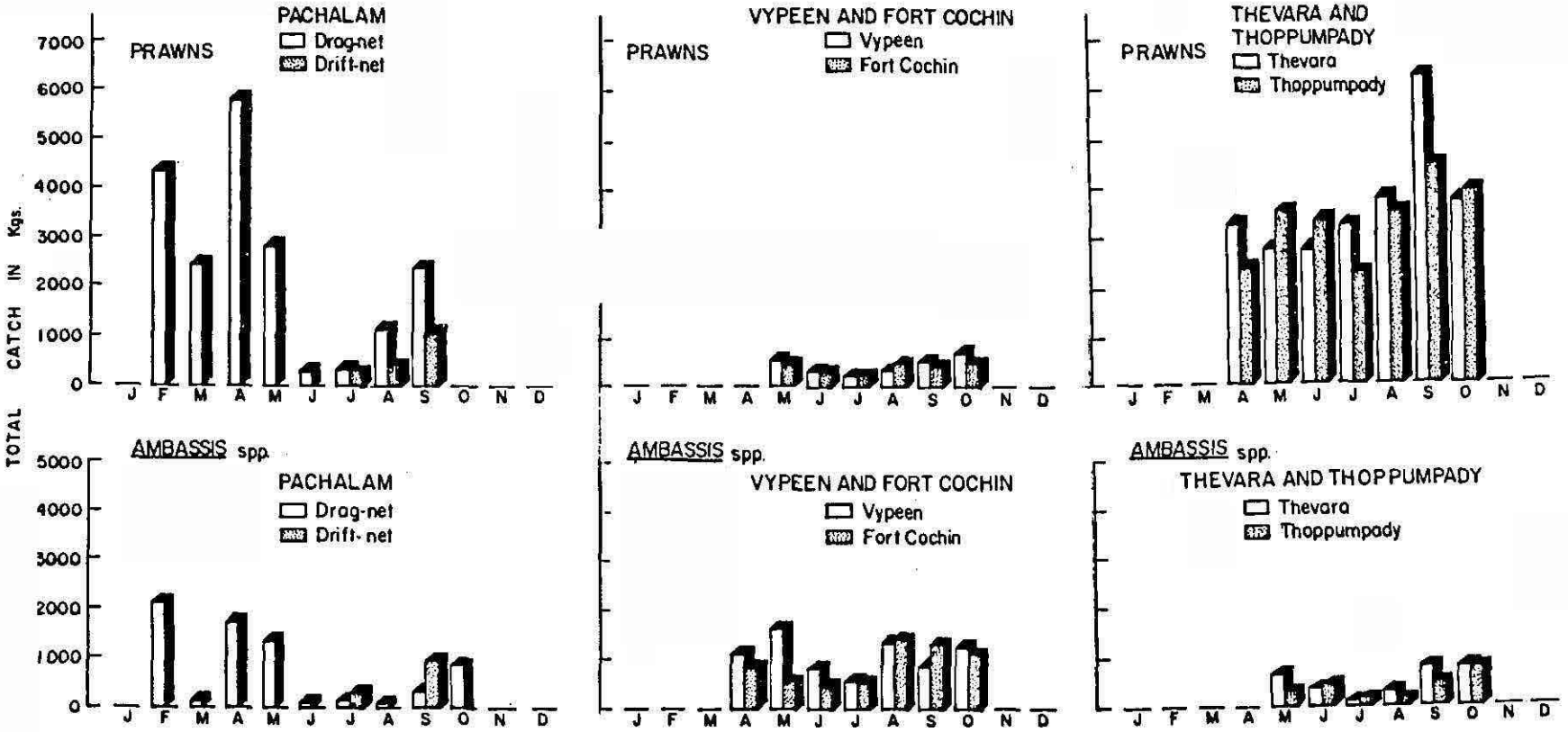
4.4. Experimental fishing

Experimental fishing on board R.V.Cadalmin using bottom trawl was conducted fortnightly. The fish caught in this comprised mainly of Johnius spp., Cynoglossus sp., Sillago sihama, Anadontostoma chacunda, Thryssa sp., Lactarius lactarius, ribbon fish and prawns like P. indicus, P. monodon and Metapenaeus dobsoni and crab, Scylla serrata. As trawling does not form part of commercial fishing in the backwaters its statistics also was not collected.

4.5. Finfish catch - Specieswise:

As already mentioned, the present study being concerned only with finfish the speciesewise catch on crustaceans is not dealt with. The finfish also indicated early, formed 50% of the total catch in stake net at Thevara, 46% in the stake net at Thoppumpady, 45% in the drag net and 73% in the drift net at Pachalam, 82% in the dip net at Vypeen and 83% in the dip net at Fort Cochin.

Fig. 3. Catch of Ambassis spp. and prawns at the different centres


PACHALAM
PRAWNS
Drag-net
Drift-net
VYPEEN AND FORT COCHIN
PRAWNS
Vypeen
Fort Cochin
THEVARA AND THOPPUMPADY
PRAWNS
Thevara
Thoppumpady
TOTAL CATCH IN Kgs.
7000
6000
5000
4000
3000
2000
1000
0
J F M A M J J A S O N D
AMBASSIS spp.
PACHALAM
Drag-net
Drift-net
AMBASSIS spp.
VYPEEN AND FORT COCHIN
Vypeen
Fort Cochin
AMBASSIS spp.
THEVARA AND THOPPUMPADY
Thevara
Thoppumpady

Various types of fish caught, according to their order of importance in the landings are considered separately below.

4.5.1. Ambasis spp. (Fig. 3)

This genus formed the most important constituent among the fish catches almost throughout the Cochin Backwaters. It formed 44% of the finfish catch by drag net at Pachalam and this place topped for its catch among the centres under observation. In dip net fishery here; it however, contributed to only 20-25%. On the other hand, in stake nets at both places, it formed 30-31%. The drift net had a very small catch at 6% only in it. In Ambassis, the main items were A. gymnocephalus and A. dayi with the former being dominant. Month-wise A. gymnocephalus was abundant in February at Pachalam, in May at Thevara, August at Thoppumpady and October at Vypeen and Fort Cochin. A. dayi occurred in July and August and it was more at Pachalam than at other centres.

The anchovy landings among the fishes varied between 5% (drag net) at Pachalam and 16% (Chinese dip net) at Vypeen. The dip net at Fort Cochin also had 15% catch. While the stake net at Thoppumpady had 13% at Thevara it was only 6%. Stolephorus commersonii was the only species caught and it was absent in the drift nets. This species was landed in almost all the months except in July and September at Thevara and in August and October at Thoppumpady. At Pachalam anchovies were caught only

in August, September and October, in quantities ranging between 170 and 401 kg. The highest catch of 733 kg was recorded at Thevara in April. The highest monthly catch at Thoppumpady was in October and it amounted to 644 kg.

4.5.3. Leiognathus spp. (Fig. 4)

The landings of leiognathids were more by the stake nets at Thevara where it formed 11% of the finfish catch, as against only 6% at Thoppumpady. In the dip net, its catch constituted only 2-3%. The landings by drag net were so insignificant at pachalam where it formed only 0.1% of the total finfish catch. At Thevara the catch of this fish was the highest in April (654 kg). Equally good catches occurred in May, July and October also, when the percentage occurrence was within 15-17.

The species constituting the fishery were L. brevirostris, L. bindus, L. daura and L. equulus. The former 2 were abundant and common, whereas the occurrence of the latter was negligent. L. daura and L. equulus occurred in the experimental trawling in May.

4.5.4. Secutor insidiator

This species was landed at Thevara and Thoppumpady, during the present study. It constituted 2% of the total fish catch at the former centre, whereas at the latter it was only 0.5%. In dip nets, drag nets and drift nets this species was not caught.

Fig. 4. Stake net catches at Thevara (Clear bars) and Thoppumpady (Strippled bars)

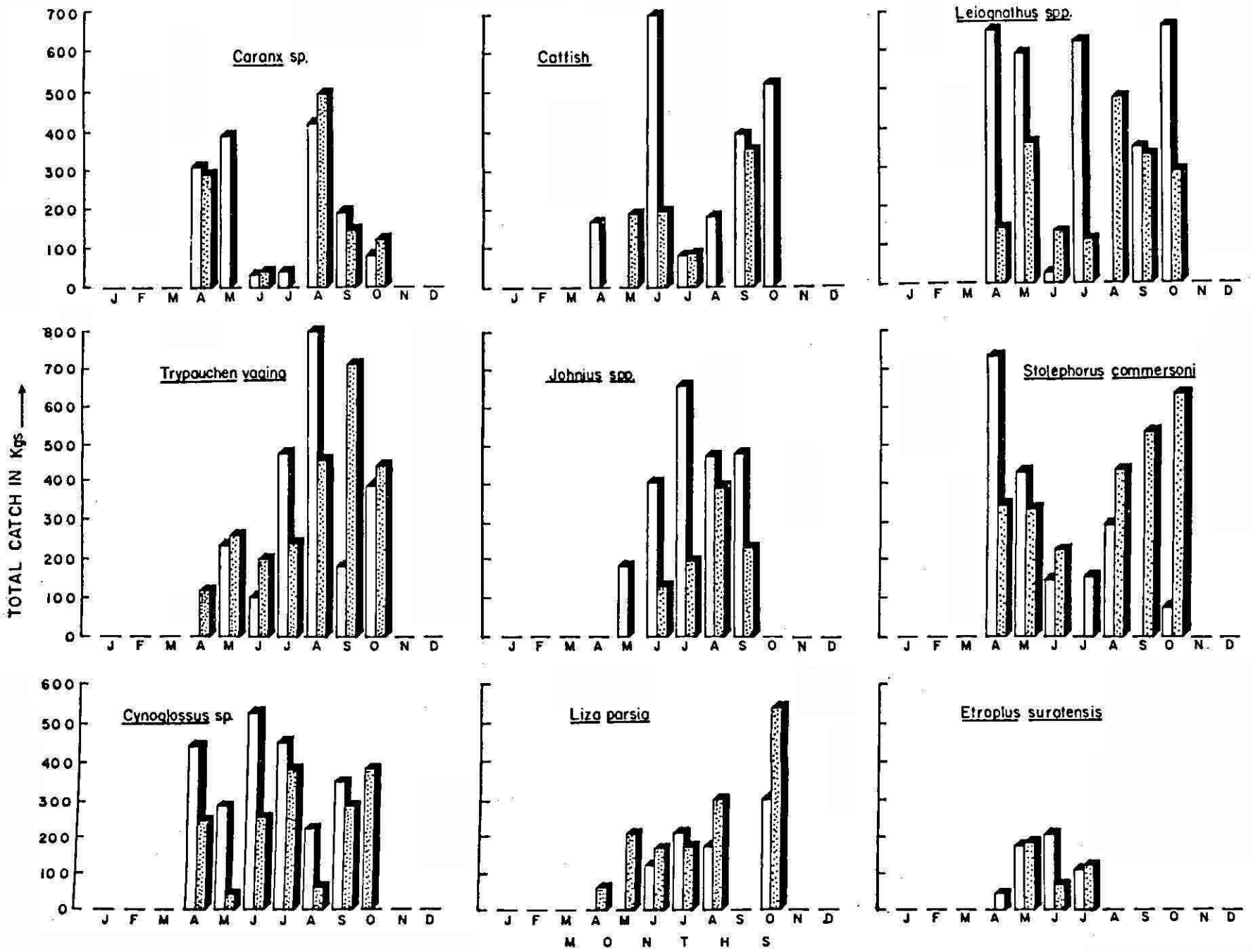
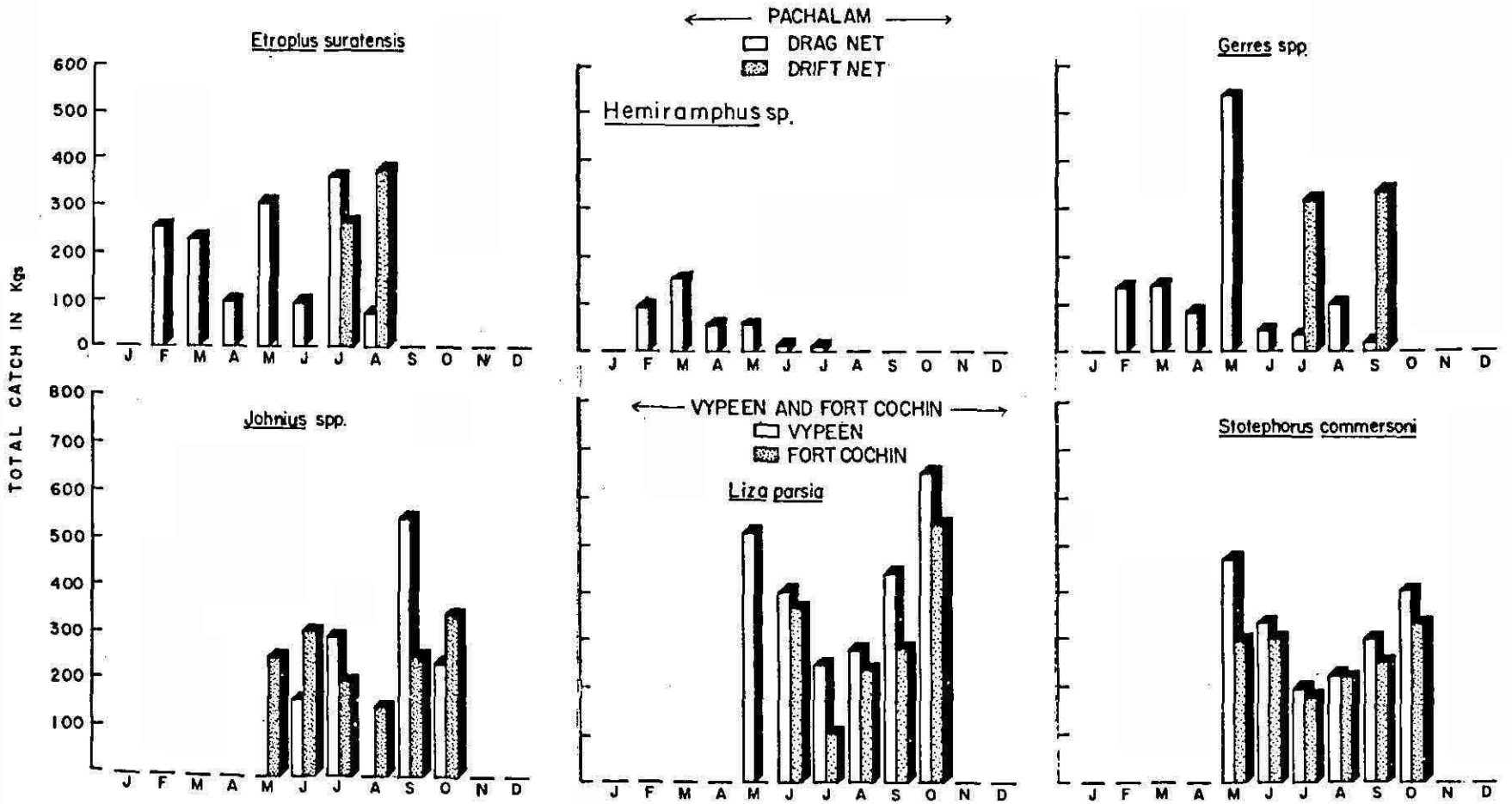

Caranx sp.
Catfish
Leiognathus spp.
Trypauchen vagina
Johnius spp.
Stolephorus commersoni
Cynoglossus sp.
Liza parsia
Etroplus suratensis
TOTAL CATCH IN Kgs
J F M A M J J A S O N D
M O N T H S

Fig. 5. Catch of different species by dip nets, drag nets and drift nets


TOTAL CATCH IN Kgs
Etroplus suratensis
600
500
400
300
200
100
0
J F M A M J J A S O N D
← PACHALAM →
DRAG NET
DRIFT NET
Hemiramphus sp.
Gerres spp.
Johnius spp.
800
700
600
500
400
300
200
100
← VYPEEN AND FORT COCHIN →
VYPEEN
FORT COCHIN
Liza parsia
Stolephorus commersoni

At Thoppumpady it was obtained in June (99.37 kg) and at Thevara, in April (481.24 kg) and June (82.63 kg).

4.5.5. Sciaenids (Fig. 4, 5)

The sciaenids, constituting the fishery was Johnius spp. They were caught in all types of gears except drag net. The stake net catches at Thevara and Thoppumpady were 8.4% and 6%. In the drift nets at Pachalam big sized sciaenids were caught, constituting about 10.2% of the total fish catch. The dip net catches were found to be 10.1% at Vypeen and 17.7% at Fort Cochin.

This species was caught in all the months at Fort Cochin, whereas at Vypeen it was absent in May and August. At Thevara in April and at Thoppumpady in April, May and October, it was not caught.

The important species which constituted the fishery were J. belangeri and J. carouna.

4.5.6. Etroplus spp. (Fig. 4, 5)

Etroplus was caught at Thevara during May - July within a catch range of 213 kg (in June) and 113 kg (in July). In the monthly finfish catch it formed 6.3% in June, 4.5% in May and 3.1% in July. At Thoppumpady it occurred during April-July, with a maximum catch of 180 kg forming 8.5% of the finfish in May. The lowest catch of 48 kg (2.1%) occurred in April. At Pachalam, drag nets landed it for a longer period from February to July, the catches varying from 32 kg in June and 303 kg in May. In

June, though the catch was less, it formed 15.1% of the month's finfish landings, whereas in May in spite of the maximum catch it formed only 10.8%. In February and March good catches of 255 (6.3%) and 227 kg (8.5%) occurred. In April the catch was 92 kg forming only 3.4% of the month's finfish landing. In July its catch formed 13.2% of the fish landings by drag nets. It was not caught in the drift nets.

In the dip nets at Vypeen Etroplus was caught only in June forming 22.8% of the month's finfish catch. Here its catch was 433 kg; where as at Fort Cochin, by the same gear in the same month, the catch was only 233 kg forming 12.7%. In other months this fish was not landed by the dip nets.

The species constituting the fishery were E. suratensis and E. maculatus of which the former dominated.

4.5.7. Cat fish (Fig. 4)

The marine cat fish, Tachysurus maculatus was caught mostly by stake nets and its maximum catch was at Thevara in July (663.0 kg = 19%)where it occurred in all the months except in May. At Thoppumpady in August and October it was not caught. The catch here in other months varied from 4% in July to 10% in April. The cat fish contributed to the drag net fishery at pachalam in February and March and the drift net fishery in July-September. The species constituted only 3% of the total fish catch at Vypeen, whereas at Fort Cochin its percentage was

almost double than that at Vypeen. The cat fish was caught in the dip nets at Vypeen only in August and September and at Fort Cochin in August - October.

4.5.8. Trypauchen vagina (Fig. 4)

Trypauchen vagina was observed to contribute to the total fish catch in considerable amounts. It was landed by the stake nets in all the months from May to October, the total catch being 2,189 kg at Thevara and 2,467 kg at Thoppumpady. In the drag net the drift net catches this species was absent. In the dip net catches at Vypeen about 2% was this species, whereas in the dip nets at Fort Cochin, it was not present.

At Thevara the catch varied from 101 kg (3%) in June to 798 kg (21%) in August. At Thoppumpady the catch varied from 120 kg (5%) in April to 716 kg (17%) in September. At these centres this species constituted 8% and 12% of the total fish catch respectively.

4.5.9. Cynoglossus sp. (Fig. 4)

Cynoglossus sp. was caught in the stake nets at Thevara in all the months under study with the total amounting to 2645 kg. The catch here varied from 526 kg (16%) in June and 219 kg (6%) in August. At Thoppumpady, except in October, in all the months Cynoglossus sp. was landed in quantities ranging from 38 kg (1.8%) in May and 378 kg (17%) in July. Again in August the catch was very less amounting upto 60 kg. The Cynoglossus

contributed to about 6% of the total finfish landings at this centre. The landings of this species by drag nets were observed only in March, April, July and October the catches being 135, 56, 4 and 242 kg respectively. Flat fish did not occur in drift nets during the study.

In dip nets at Vypeen and Fort Cochin, Cynoglossus sp. was caught only in September-October and August-October respectively. At Vypeen it constituted 4% and at Fort Cochin 6%, of the total fish catch.

4.5.10. Carangids (Fig. 4)

Carangid fishes were caught mostly by the stake nets, the total being landed about 1530 kg (8.6%) and 1165 kg (6%) at Thevara and Thoppumpady respectively. At Thevara this fish was caught in all the months from April to October. At Thoppumpady it was not caught in May and July. The highest monthly catch stood at 544 kg (13%) in August at Thoppumpady. Carangids were caught in the drag nets at Pachalam only in August (3%) and October (7%), and was not caught by the drift nets. At Vypeen, in the dip net landings, carangids were observed in July, August and September constituting 6, 13 and 5% of the total fish catch, whereas at Fort Cochin, it was caught by the dipnets only in August. The catch was the least at Fort Cochin, being about 0.4% of the total finfish landing.

4.5.11. Liza spp. (Fig. 4, 5)

Liza parsia constituted 3% and 4% of the total stake net fish catch at Thevara and Thoppumpady respectively. At Thevara, this species occurred in June, July, August and October, the catch being the maximum in October (301 kg). At Thoppumpady, except in September and October, this fish was caught in all the months in quantities ranging from 59 kg in April to 298 kg in August. At Pachalam it was caught in the drag nets in February, March, June and October, with the highest catch of 650 kg (20%) occurring in October. In the drift net catches of July and August it constituted 6% and 30% respectively. In the total fish landings by the gear during the period of observation it formed one tenth.

This species was caught by the dip nets at Vypeen in all the months (May-October). But at Fort Cochin, it was not landed in May. Liza spp. formed 21% and 15% respectively at the above 2 places. However, their percentage was higher at Vypeen, ranging from 12% in September to 29% in May, whereas at Fort Cochin it varied between 6% in July and 21% in August. L. parsia was the dominant item in the mullets at Fort Cochin and Vypeen also. The species L. macrolepis occurred in stray numbers along with L. parsia.

4.5.12. Gerres spp. (Fig. 5)

Gerres spp. form a commercially important item among the finfishes exploited in the backwaters in general. The species

constituting the fishery were G. filamentosus and G. oyena, both enjoying equal importance.

Highest catches of Gerres in the backwaters occurred at Pachalam, almost throughout the period of study in drift net, yielding a total of 1101 kg forming 6.5% in the finfish catch of the place. The maximum catches in the unit here appeared in May accounting for 19% of the month's fish catch.

In February and March also Gerres were caught in good quantities, but other fishes being more, its percentage was less. In June though the catch was less it stood next to Ambassis in the order of importance when the percentage in the month's finfish catch is taken into consideration. In the drift net catches also it totalled to 349 kg forming 8% of the finfish catch.

At Fort Cochin and Vypeen the total catch in the period under observation amounted to 568 kg forming 5.5% and 482 kg forming 4% at Vypeen. While these fish were most common during August-October at Fort Cochin, it was common at Vypeen in May - June.

In the stake net catches at Thevara and Thoppumpady Gerres spp. were caught only during July-September. The catch at Thevara totalled to 255 kg accounting for 1% of the finfish catch of the place. At Thoppumpady it was slightly more as it stood at 375 kg (forming 2%)of the total finfish landings.

4.5.13. Sillago sihama

This fish did not occur in the stake net fishery at Thevara and Thoppumpady. In the drag net fishery during February-October at Pachalam, it occurred only in July and August, the catches amounting to 21 kg forming 7% of the finfish catches in the former and 2 kg accounting to only 0.3% of the finfish catch in the latter month. In the drift net fishery at the centre during July-September Sillago catches were rather good. While the landing in July by the unit was 43 kg it increased to 309 kg in the next month and 336 kg in the month after. The percentages of this fish in the monthly finfish catch were 3.6, 33.9 and 14.4 respectively. The total during the 3 month's period amounted to 688 kg forming 15.7% in the finfish catch.

In the dip net fishery at Fort Cochin and Vypeen also, the species figured well during August-October. It occurred at both the centres in August. But at Fort Cochin, it was more with a catch of 160 kg forming 14.4% in the finfish as against 76 kg forming 6.3% at Vypeen. In September it was not available at Fort Cochin but at Vypeen its catch increased to 282 kg forming 8% in the finfish catch of the month. Subsequently in October, the fish appeared only at Fort Cochin amounting to 382 kg forming 10.8% in the finfish catch.

4.5.14. Hemiramphus sp.

Hemiramphus sp. was represented in the drag net catches at Pachalam during February-July period. The total catch in the above 5 months is estimated to be 352 kg. In the total finfish catch by the drag net at this place this formed 2%. In the monthwise estimate the catch was the highest in March when it formed 5.5% of the finfish landings. Though the catch was the lowest in July, in percentage of the total catch for the month, it accounted for 3.6. Similarly in June also the catch was almost the same but it formed 6.9% in the total catch.

4.5.15. Thryssa spp.

Under this genus the species caught in the backwaters were T. setirostris and T. mystax. Of these, two, the second one was dominant. Thryssa spp. were landed at Vypeen, only in September, where it amounted to 89 kg forming 2.5% of the month's finfish catch. At Fort Cochin also, highest catch was 89 kg. But it occurred in October. As at Vypeen here also it formed 2.5% in the month's finfish catch. Unlike Vypeen this species was caught at Fort Cochin in May too when it amounted to 27 kg accounting for 2.1%.

4.5.16. Platycephalus crocodilus

P. crocodilus was found to contribute to the drag net fishery during July-September at Pachalam where its catch

ranged between 4 kg forming only 0.8% in August and 136 kg forming 16.5% in September. In July also the catch was low at 10 kg but contributing to 3% of the fish catch of the month. In the drift net fishery at Pachalam it played a bigger role though it occurred only in July and August, with respective catches of 138 kg and 103 kg. In the total finfish catch of these months its percentage stood between 11.3 in August and 11.8 in July.

Excluding Pachalam, this fish occurred only at Thevara, where a single specimen was caught in a stake net in the last week of October.

4.5.17. Miscellaneous items

The species of fish other than those mentioned above constitute a minor portion of the total landings at all centres of study. Included in this category are fishes coming under the genera Escualosa, Ehirava, Anadontostoma, Eleutheronema, Eutherapon, Lactarius, Sorotherodon, Pampus, Tetradon, Trichiurus, Anguilla and Austrobatrachus.

Escualosa thoracata formed 2.3% of the total finfish catch in August by drag nets at Pachalam. In October a good catch of 222 kg forming 6.9% in the finfish was observed. This species was absent in the drag nets during February-July and in September and was not landed by the drift nets. At Thoppumpady, E. thoracata was landed by stake nets only in

June, which was about 97 kg forming 4.4% of the month's finfish catch. In the total fish landings, the contribution of this species, was a meagre one of only 0.5%. At Thevara and in the dip net catches at Vypeen and Fort Cochin, this species did not occur.

Ehirava fluviatilis occurred only in the stake net at Thoppumpady in October contributing 80 kg forming 2.9% of the month's finfish catch.

Anadontostoma chacunda was obtained by stake nets at Thevara in June forming only 0.2% of the month's finfish catch. At Fort Cochin it was caught in the dip nets in July and August where it formed 0.5% in the 2 months catch pooled together. This species was not represented in the catches at other centres.

Three hundred and fifty two kg of Mugil cephalus was caught by the Chinese dip nets at Fort Cochin in September forming 14.8% of the month's finfish catch. In the other months this species did not occur as a fishery. Nevertheless very young ones of M. cephalus was caught in the same gear in June and July. At Vypeen also, in September, a good catch of 217 kg forming 6.1% of the finfish catch of the month occurred. At Fort Cochin it constituted about 3.4% and at Vypeen 1.8% of the respective total finfish landings by the dip nets. In the stake net,, drag net and drift net catches this species did not occur.

Eleutheronema tetradactylum occurred in the stake net catches at Thevara only in September. Its catch was 39 kg, which formed 2.4% of the total finfish catch of the month. In the previous months and in October this species was not landed. It did not occur in the stake nets at Thoppumpady, dip nets at Vypeen and Fort Cochin and drag nets and drift nets at Pachalam. Eleutheronema constituted only 0.2% of the total finfish catch at Thevara during the period of study.

Eutherapon theraps was caught only in the stake nets at Thevara in the months of September and October. The catch in September was 77 kg forming 2.4% of the month's finfish catch and in October, 48 kg forming 1.1%. The total catch constituted to about 0.5% of the centre's finfish catch during the period of study.

Lactarius lactarius was caught by the dip net at Fort Cochin only and its capture was restricted to October alone. The amount caught was 37 kg which becomes 1% in the finfish catch of the month. A few specimens of this species were found in the experimental trawling in the shipping channel in June.

Sorotherodon mossambica was found in the catches in small quantities at Thevara in stake nets and at Pachalam in drag nets. In drift net at the latter place, it did not occur. At Thevara the landings of this species occurred only

in June and July, accounting for 17 kg forming 0.5% and 78 kg forming 2.2% respectively in the monthly finfish catches. At Pachalam, however, this fish occurred for a longer period early from February onwards extending to May with comparatively high catches ranging from 58 kg forming 1.4% in February to 300 kg forming 11% in April. In the total finfish catch at this place, during the 4 months period, it formed about 5%.

Pampus argenteus was landed only by the stake nets at Thevara in June, the catch being 56 kg which formed 1.6% of the months finfish catch and 0.2% of the total finfish catch at the centre.

Puffer fish Tetradon sp. also was caught in the stake nets, only at Thevara in June. Its catch was about 9 kg forming 0.25% of the finfish landings of the month. This species was not landed elsewhere.

Ribbon fish, Trichiurus sp. amounted to 56 kg in the landing in July at Thevara and 99 kg in June at Thoppumpady. It was not caught by any other net at any other place.

Eel, Anguilla sp. occurred in the stake net catches at Thevara and Thoppumpady. At Thevara its catch was 232 kg forming 5.5% of the finfish catch in October and at Thoppumpady 118 kg forming 2.8% in September. It did not occur in the dip nets at Vypeen and Fort Cochin and in the drag nets and drift nets at Pachalam.

Austrobatrachus dussumieri was caught by the dip nets at Vypeen and Fort Cochin in June - July and August respectively. The catch at Fort Cochin was 25 kg forming 2.3% of the month's finfish landings in August. At Vypeen it formed 1.7% in June and 1.6% in July. At Thoppumpady, 28, 33 and 31 kg were landed in April, June and July forming 1.2, 1.5 and 1.4% respectively. It was not caught at Thevara (stake nets) and Pachalam (drag nets and drift nets).

4.5.18. Stray items

Stray occurrences of Elops saurus and Megalops cyprinoides were observed in May and August in dip nets at Vypeen and in October in stake net at Thevara. The stray items were more at Vypeen and Thevara. Fishes like Scatophagus argus and Triacanthus sp. were caught in stray numbers at Fort Cochin also, as at Vypeen in July. Young ones of mackerel, Rastrelliger kanagurta were caught at Vypeen in dip net and the shipping channel by trawl net in September and drag net at Pachalam in August. At Pachalam the other stray item was Strongylura strongylura occurring in the drag nets in July. The trawl net caught a few specimens of Synaptura sp. in June. It was found in the stake nets at Thevara also in the same month. In the dip nets at Vypeen it, however, occurred in September. Pellona sp. was yet another species that occurred in the trawl catches in September and stake net at Thevara in May. Other than these the fishes that were present in negligible numbers, with their

time of occurrence given in brackets, at Vypeen are Ctenochaetus strigosus (July), Sardinella longiceps (September), Chanos chanos (June), Lates calcarifer (June) and Valamugil cunnesius (July). Similarly the species of fish that occurred in sparing numbers only at Thevara, months of occurrence given in brackets, are Epinephelus sp. (September), Holocentrus rubrum (October), Siganus oramin (March), Cybium guttatum (May), Sphyraena sp. (May) and Tetradon sp. (September).

4.6. Length frequency

The percentage distribution of the fishes in each length group is graphically represented (Fig. 6). The results obtained are detailed below.

4.6.1. Anadontostoma chacunda (Fig. 6)

During its period of occurrence in May-August, its size ranged between 70 and 80 mm in the first 2 months and 70 and 90 mm in the next 2 months. The mode which was at 75 mm in May increased to 80 mm in July and stayed at it in August. The species thus showed only 10 mm increase between June and July.

4.6.2. Stolephorus commersonii (Fig. 6)

During the period April-September fishes varying in sizes from 55 to 100 mm occurred except in July when a small percentage were found between 105-120 mm also. In April the maximum number occurred in 60 mm size group and in the following 2 month in 65 mm group. In July the maximum number was at size groups 75 and 80 mm. In the bigger fish, 115 mm size was more. In August and September when the length range was long the modes occurred were more than one. In August the primary mode stood at 65 mm with 28%. After a secondary mode at 80 mm, it

appears again to move to another mode at 100 mm. In September there are 2 modes of almost equal importance at 80 and 95 mm. The fish in general appears to have very fast growth with the mode moving from 65 mm in May to 80 mm in July.

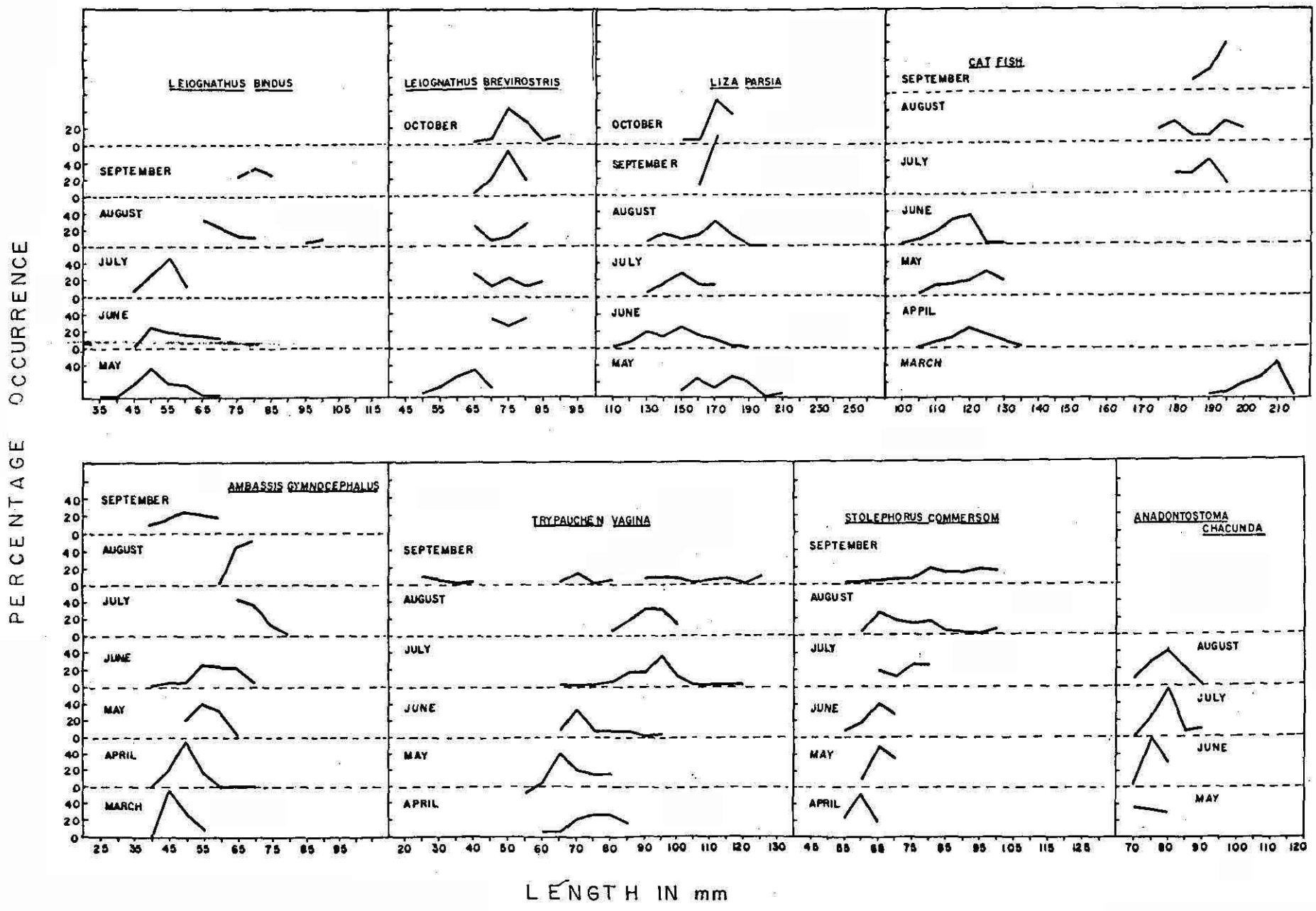
4.6.3. Tachysurus sp. (Fig. 6)

Widely separated size ranges is peculiar to this fish in the backwaters. In March the size ranged between 190 and 215 mm with the mode at 210 mm. Suddenly during April-June the sizes ranged between 100 and 135 mm with the modes around 120-125 mm. In July-September period again bigger fish of size range 175-200 mm occurred in the catches.

4.6.4. Liza parsia (Fig. 6)

This fish shows wide ranges in length in its fishery during May-August period with 110-210 mm of 10 mm size groups. Stray specimens with even 240-250 mm size groups were also caught in July. The modes from June to August indicate an increase from 130 to 170 mm showing 20 mm growth per month. In September-October, the size range was narrow between 150 and 180 mm with mode at 170 mm.

Fig. 6. Length distribution of different species of fish


LEIOGNATHUS BINDUS
LEIOGNATHUS BREVIROSTRIS
LIZA PARSIA
CAT FISH
AMBASSIS GYMNOCEPHALUS
TRYPAUCHEN VAGINA
STOLEPHORUS COMMERSOM
ANADONTOSTOMA CHACUNDA
PERCENTAGE OCCURRENCE
LENGTH IN mm

4.6.5. Ambassis gymnocephalus (Fig. 6)

This species occurred from March to September and the size varied from 40 to 80 mm. The mode in March was at 45 mm group with a percentage of 58. It shifted to 50 mm group in April and to 55 mm group in May. In June the mode remained at the same size group but the percentage decreased to 28 from 42 of May. In July the mode was at 65 mm group. In the following month the mode moved on to 70 mm group. September showed entry of younger fishes with the mode at 50 mm group.

4.6.6. Leiognathus bindus (Fig. 6)

In May the fish ranged in size between 35 and 70 mm with mode at 50 mm. In June the range was between 45 and 70 mm. Though the mode remained in the same place the percentage of bigger size was more. Size in the following month was 45-60 mm, with the mode progressing to 55 mm group. August showed 2 different length ranges of 65-80 mm and 95-100 mm. September had only a short range of 75-85 mm with mode at 80 mm group. The species appears to be a fast growing one as the mode at 50 mm in June seems to have advanced to 80 mm group in September.

4.6.7. Leiognathus brevirostris (Fig. 6)

In May its range in size and mode were respectively 50-70 mm and 65 mm. The size in June started at 70 mm

extending to 85 mm. In the subsequent 4 months the length commenced at 65 mm, its range spreading up to 90 mm in October. Though no definite modes could be decifered in June-August period, the catches exhibited 75 mm as the dominant group in September and October. The length distribution as collected in this study may indicate continuous recruitment of this fish in to the fishery.

4.6.8. Trypauchen vagina (Fig. 6)

Occurrence of this species was continuous from April to September. In April the sizes caught ranged from 60 to 85 mm with peak at 75-80 mm groups. In May fish were smaller within 55-80 mm range and 65 mm mode. In June and July the sizes in catch commenced at 65 mm. While its range concluded at 95 mm group in the former of the 2 months, it went on till 120 mm in the latter one. The mode in June was at 70 mm, as against 95 mm of July. The fishes caught in August had only a narrow range within 80-100 mm. The mode stood in the month at 90-95 mm sizes. In September 3 different batches comprising of fishes in sizes 25-40, 65-80, and 90-125 mm were obtained. Though there was no definite dominating mode in the fishery, the entry of small ones indicates commencement of fresh recruitment. The shifting of modal sizes indicates the fish to grow 30 mm from 65 mm in April to 90 mm in August showing 10 mm increase per month.

Table 3

Sl. No.	Name of fish	Size range	mode in 5 mm range
1.	Elops saurus	73,78	-
2.	Megalops cyprinoides	86,89	-
3.	Sardinella longiceps	89-96	-
4.	Escualosa thoracata	81-113	90
5.	Pellona sp.	61-78	-
6.	Ehirava fluviatilis	36-52	40
7.	Thryssa mystax	100-211	110
8.	T. setirostris	108-112	-
9.	Chanos chanos	96	-
10.	Anguilla sp.	418-479	460-465
11.	Strongylura strongylura	332-358	-
12.	Hemiramphus sp.	76-171	-
13.	Holocentrus rubrum	100-118	-
14.	Sphyraena sp.	72-94	-
15.	Mugil cephalus	300-400	350
		43-54	-
16.	Valamugil cunnesius	124	-
17.	Liza macrolepis	118,121	-
18.	Eleutheronema tetradactylum	73-84	-
19.	Lates calcarifer	93	-
20.	Ambassis dayi	73-86	-

21.	Epinephelus sp.	93-96	-
22.	Eutherapon theraps	92-96	-
23.	Sillago sihama	131-171 234-323	145 275
24.	Lactarius lactarius	60-80	-
25.	Caranx sexfasciatus	75-125	85
26.	C. malabaricus	74-90	75
27.	Lutianus argentimaculatus	58,68,72	-
28.	Gerres filamentosus	73-86, 134,196	75
29.	Gerres oyena	69-84	70
30.	Secutor insidiator	29-59	35,(50)
31.	Leiognathus daura	47-71	50
32.	L. equulus	22,61	-
33.	Johnius belangeri	47-130, 241	90,110 (55)
34.	J. carouna	56-101	85
35.	Scatophagus argus	80,138	-
36.	Sorotherodon mossambica	84-114	95
37.	Etroplus suratensis	83-111	95
38.	E. maculatus	25-83	70
39.	Siganus oramin	62-74	65
40.	Ctenochaetus strigosus	94	-
41.	Trichiurus sp.	118-550	400
42.	Rastrelliger kanagurta	89-118	115

43.	Cybium guttatum	75,106-117	-
44.	Pampus argenteus	88-131	-
45.	Platycephalus crocodilus	111-180,234	-
46.	Synaptura sp.	114-201	-
47.	Cynoglossus sp.	21-34	-
		61-89	70
48.	Triacanthus sp.	72	-
49.	Tetradon sp.	145	-
50.	Austrobatrachus dussumeri	112-215	135

4.6.9. Miscellaneous and stray items

There were 50 items under this category. They being caught only occassionally and rarely either in small or negligible numbers, monthly length frequency studies could not be attempted. However, the range in size of these fish with mode if any, are given in Table-3.

4.7. Length-weight relationship

Length-weight relationship on 14 species of fish caught in the backwaters were done using the equation given in material and methods. In Anguilla sp. and Leiognathus bindus the number of specimens available for the study was small, hence separate study on the male and female was not attempted. In all other species dealt with, relations in male and female were independently found and their significance put to F test.

The length-weight relationship observed in each fish are given below and the results of F test in Table 2 A - L. In cases where no significance exist between the male and female, pooled values were also found.

1. Escualosa thoracata (Fig. 7)

$$\text{Female } \log W = -3.6435 + 2.3116 \times \log L$$

$$r = 0.7547$$

Male log	W	=	-3.6954 + 2.3412 x log L.
	r	=	0.8120
Combined log	W	=	-3.6002 + 2.2913 x log L
	r	=	0.9093

2. Anadontostoma chacunda (Fig. 7)

Female log	W	=	-5.7681 + 3.4587 x log L
	r	=	0.8281
Male log	W	=	-6.1535 + 3.6619 x log L
	r	=	0.8102
Combined log	W	=	-5.9555 + 3.5576 x log L
	r	=	0.818468

3. Stolephorus commersonii (Fig. 7)

Female log	W	=	-5.9299 + 3.4735 x log L
	r	=	0.9855
Male log	W	=	-5.4493 + 3.2140 x log L
	r	=	0.9856
Combined log	W	=	-5.6658 + 3.3296 x log L
	r	=	0.9849

Table 2 A

Escualosa thoracata

	df	Σx^2	Σxy	Σy^2	Regression coefficient	Deviations from Regression		
						df	S.S.	M.S.
Within								
Male	53	0.046221	0.1081513	0.3837766	2.3398737	52	0.1307162	0.00251377
Female	48	0.0341188	0.0788677	0.3201536	2.3115614	47	0.1378464	0.00293289
						99	0.2685626	0.002712753
Pooled, W	101	0.0803398	0.1870190	0.7039302	2.3278500	100	0.2685780	0.00268578
			Difference between slopes			1	0.0000154	0.00001540
Between B	1	0.0091959	0.01813180	0.0357640				
W + B	102	0.0895357	0.2051508	0.7396420	2.2912738	101	0.269585355	0.0026691617
			Between adjusted mean			1	0.001007355	0.001007355

Comparison of slopes : $F_{(1,99)} = \frac{0.0000154}{0.002712753} = 0.005676889$ Not significant

Comparison of elevations: $F_{(1,100)} = \frac{0.001007355}{0.00268578} = 0.375080984$ Not significant

Table 2 B

Anadontostoma chacunda

	df	Σx^2	Σxy	Σy^2	Regression coefficient	Deviations from Regression		
						df	S.S.	M.S.
Within								
Male	30	0.02012275	0.073688077	0.41104389	3.661928762	29	0.141203401	0.004869082
Female	29	0.0214262	0.07410668	0.373786463	3.458694496	28	0.11747096	0.004195503
						57	0.258674361	0.004538146
Pooled, W	59	0.04154895	0.147794757	0.784830353	3.557123754	58	0.259106112	0.004467346
			Difference between slopes			1	0.000431751	0.000431751
Between B	1	0.00000665	0.000043643	0.000298847				
W + B	60	0.0415556	0.1478384	0.7851292	3.557604751	59	0.259178605	0.004392857
			Between adjusted mean			1	0.000072493	0.000722

Comparison of slopes : $F_{(1,57)} = \frac{0.000431751}{0.004538146} = 0.951381907$ Not significant

Comparison of elevations : $F_{(1,58)} = \frac{0.000072493}{0.004467346} = 0.016227308$ Not significant

Table 2 C

Stolephorus commersoni

	df	Σx^2	Σxy	Σy^2	Regression coefficient	Deviations from Regression		
						df	S.S.	M.S.
Within								
Male	94	0.2505010	0.8701335	3.1117750	3.47357296	93	0.089302803	0.000960245
Female	74	0.3092135	0.9938189	3.2884822	3.2140217	73	0.094326686	0.001292146
						166	0.183629489	0.001106201
Pooled, W	168	0.5597145	1.8639524	6.4002572	3.33018262	167	0.192952316	0.001155403
			Difference between slopes			1	0.009322827	0.009322827
Between B	1	0.0045872	0.01497507	0.04895698				
W + B	169	0.5643017	1.87892747	6.44921418	3.329650558	168	0.193042282	0.001149061
			Between adjusted mean			1	0.000089966	0.000089966

Comparison of slopes : $F_{(1,166)} = \frac{0.009322827}{0.001106201} = 8.427787536$ Significant at 1% level

Comparison of elevations: $F_{(1,167)} = \frac{0.000089966}{0.001155408} = 0.077865472$ Not significant

Table 2 D

Liza parsia

	df	Σx^2	Σxy	Σy^2	Regression coefficient	Deviations from Regression		
						df	S.S.	M.S.
Within								
Male	52	0.1779076	0.4870477	1.7233687	2.737644148	51	0.390005414	0.007647164
Female	105	0.3259241	1.0575960	3.7814435	3.431809121	104	0.349634378	0.00336186
						155	0.739639792	0.004771869
Pooled, W	157	0.5038317	1.5446437	5.5048122	3.065793	156	0.7692543	0.004931117
			Difference between slopes			1	0.029614508	0.0296140
Between B	1	0.0754499	0.2379852	0.7567425				
W + B	158	0.5792816	1.7826289	6.2615547	3.077309723	157	0.775853453	0.0049041741
			Between adjusted mean			1	0.006599153	0.006599153

Comparison of slopes : $F_{(1,155)} = \frac{0.029614508}{0.004771869} = 6.206060560$ Not significant

Comparison of elevations : $F_{(1,156)} = \frac{0.006599153}{0.00493111} = 1.343702824$ Not significant

Table 2 E

Ambassis gymnocephalus

	df	Σx^2	Σxy	Σy^2	Regression coefficient	Deviations from Regression		
						df	S.S.	M.S.
Within								
Male	41	0.01297	0.03126	0.1138	2.410177332	40	0.0384578	0.000961446
Female	32	0.01228	0.03758	0.1437	3.060260586	31	0.028695407	0.000925658
						71	0.067153207	0.000945819
Pooled, W	73	0.02525	0.06884	0.2575	2.726336634	72	0.069818986	0.000969708
			Difference between slopes			1	0.002665779	0.002665779
Between B	1	0.0002800	0.001530	0.007900				
W + B	74	0.02553	0.07037	0.2654	2.756365061	73	0.07143459	0.000978556
			Between adjusted mean			1	0.001615604	0.001615604

Comparison of slopes : $F_{(1,71)} = \frac{0.002665779}{0.000945819} = 2.81848747$ Not significant

Comparison of elevations : $F_{(1,72)} = \frac{0.001615604}{0.000969708} = 1.666072673$ Not significant

Table 2 F

Gerres filamentosus

	df	Σx^2	Σxy	Σy^2	Regression coefficient	Deviations from Regression		
						df	S.S.	M.S.
Within								
Male	47	0.02082265	0.05778818	0.31789399	2.775255791	46	0.157517008	0.003424282
Female	53	0.0213998	0.05780673	0.30249245	2.701274311	52	0.146340615	0.002814242
						98	0.303857623	0.003100587
Pooled, W	100	0.04222245	0.11559491	0.62038644	2.737626497	99	0.303915386	0.003069852
			Difference between slopes			1	0.000057763	0.000057763
Between B	1	0.00009755	0.00000509	0.00131356				
W + B	101	0.04232	0.11560	0.62170	2.731568998	100	0.305930623	0.00305930623
			Between adjusted mean			1	0.002015237	0.002015237

Comparison of slopes : $F_{(1,98)} = \frac{0.000057763}{0.003100587} = 0.018629698$ Not significant

Comparison of elevations : $F_{(1,99)} = \frac{0.002015237}{0.003069852} = 0.656460637$ Not significant

Table 2 G

Secutor insidiator

	df	Σx^2	Σxy	Σy^2	Regression coefficient	Deviations from Regression		
						df	S.S.	M.S.
Within								
Male	92	0.4069916	1.258442074	4.776262081	3.092059084	91	0.885084834	0.009726206
Female	63	0.25956587	0.80608548	3.349043665	3.105514142	62	0.845733807	0.013640867
						153	1.730818641	0.01131254
Pooled, W	155	0.66655747	2.064527554	8.125305746	3.097298653	154	1.730847334	0.011239268
			Difference between slopes			1	0.000028693	0.000028693
Between B	1	0.0205334	0.051214433	0.153155582				
W + B	156	0.68709087	2.115741987	8.278461328	3.079275361	155	1.763509156	0.011377478
			Between adjusted mean			1	0.032661822	0.032661822

Comparison of slopes : $F_{(1,153)} = \frac{0.000028693}{0.01131254} = 0.00112472$ Not significant

Comparison of elevations : $F_{(1,154)} = \frac{0.032661822}{0.011239268} = 2.906045305$ Not significant

Table 2 H

Leiognathus brevirostris

	df	Σx^2	Σxy	Σy^2	Regression coefficient	Deviations from Regression		
						df	S.S.	M.S.
Within								
Male	31	0.03794092	0.107927004	0.406565491	2.84460931	30	0.099555587	0.003318519
Female	33	0.04016912	0.112366623	0.392186664	2.797338428	32	0.077859191	0.002433099
						62	0.177414778	0.002861528
Pooled, W	64	0.07811004	0.220293627	0.798752155	2.8202996	63	0.1774580	0.00281679
			Difference between slopes			1	0.000043222	0.000043222
Between B	1	0.001848476	0.007791113	0.032849674				
W + B	65	0.079958516	0.228084740	0.831601829	2.852538434	64	0.180981342	0.0002827833
			Between adjusted mean			1	0.003523342	0.003523342

Comparison of slopes : $F_{(1,62)} = \frac{0.000043222}{0.002861528} = 0.015104517$ Not significant

Comparison of elevations : $F_{(1,63)} = \frac{0.003523342}{0.00281679} = 1.250835881$ Not significant

Table 2 I

Johnius belangeri

	df	Σx^2	Σxy	Σy^2	Regression coefficient	Deviations from Regression		
						df	S.S.	M.S.
Within								
Male	30	0.21142556	0.576881006	2.002809942	2.728530108	29	0.428772748	0.014785267
Female	36	0.10716523	0.268264335	0.943959012	2.503277742	35	0.272418873	0.007783396
						64	0.701191621	0.010956119
Pooled, W	66	0.31859079	0.845145341	2.946768954	2.652761371	65	0.70480004	0.010843077
			Difference between slopes			1	0.003608419	0.00368419
Between B	1	0.00289597	0.003861059	0.005142546				
W + B	67	0.32148676	0.8490064	2.9519115	2.640875164	66	0.709791584	0.010754417
			Between adjusted mean			1	0.004991544	0.004991544

Comparison of slopes : $F_{(1,64)} = \frac{0.003608419}{0.010956119} = 0.329351935$ Not significant

Comparison of elevations : $F_{(1,65)} = \frac{0.004991544}{0.010843077} = 0.460343895$ Not significant

Table 2 J

Johnius carouna

	df	Σx^2	Σxy	Σy^2	Regression coefficient	Deviations from Regression		
						df	S.S.	M.S.
Within								
Male	74	0.32844917	0.82324782	3.687217691	2.506469479	73	1.623772157	0.022243454
Female	40	0.17372068	0.651240105	3.771624561	3.748777089	39	1.330270576	0.034109501
						112	2.954042733	0.026375381
Pooled, W	114	0.50216985	1.474487925	7.458842252	2.936233478	113	3.129401444	0.027693818
			Difference between slopes			1	0.175358711	0.175358711
Between B	1	0.00673015	0.036196075	0.165667748				
W + B	115	0.5089	1.510684	7.624510	3.01327622	114	3.140001948	0.027543876
			Between adjusted mean			1	0.010600504	0.010600504

Comparison of slopes : $F_{(1,112)} = \frac{0.175358711}{0.026375381} = 6.648575465$ Significant at 5%

Comparison of elevations : $F_{(1,113)} = \frac{0.010600504}{0.027693818} = 0.382775101$ Not significant

Table 2 K

Trypauchen vagina

	df	Σx^2	Σxy	Σy^2	Regression coefficient	Deviations from Regression		
						df	S.S.	M.S.
Within								
Male	28	0.1380	0.3308	1.0423	2.39710	27	0.2493	0.009235
Female	30	0.1205	0.3480	1.1115	2.8874	29	0.10999	0.003793
						56	0.35929	0.0064159
Pooled, W	58	0.2585	0.6788	2.1538	2.62592	57	0.37133	0.0065145
			Difference between slopes			1	0.01551	0.01551
Between B	1	0.0001	0.0003	0.0027				
W + B	59	0.2586	0.6791	2.1565	2.6261	58	0.37314	0.0064
			Between adjusted mean			1	0.00181	0.00181

Comparison of slopes : $F_{(1,56)} = \frac{0.01551}{0.0064} = 2.4197$ Not significant

Comparison of elevations : $F_{(1,57)} = \frac{0.00181}{0.0065145} = 0.27784$ Not significant

Table 2 L

Cynoglossus sp.

	df	Σx^2	Σxy	Σy	Regression coefficient	Deviations from Regression		
						df	S.S.	M.S.
Within								
Male	25	0.158387456	0.461077965	1.435233016	2.911076272	24	0.092999892	0.003874995
Female	51	0.89423501	2.755706958	8.69952092	3.081636178	50	0.207434663	0.004148693
						74	0.300434555	0.004059926
Pooled, W	76	1.052622466	3.216784923	10.13475394	3.055972133	75	0.304280026	0.004057067
			Difference between slopes			1	0.003914299	0.003914299
Between B	1	0.010444864	0.034418137	0.11341419				
W + B	77	1.06306733	3.25120306	10.2480993	3.058322806	76	0.304870833	0.004011458
			Between adjusted mean			1	0.000590807	0.000590807

Comparison of slopes : $F_{(1,74)} = \frac{0.003914299}{0.004058693} = 0.964130627$ Not significant

Comparison of elevations : $F_{(1,75)} = \frac{0.000590807}{0.004057067} = 0.145624166$ Not significant

Fig. 7

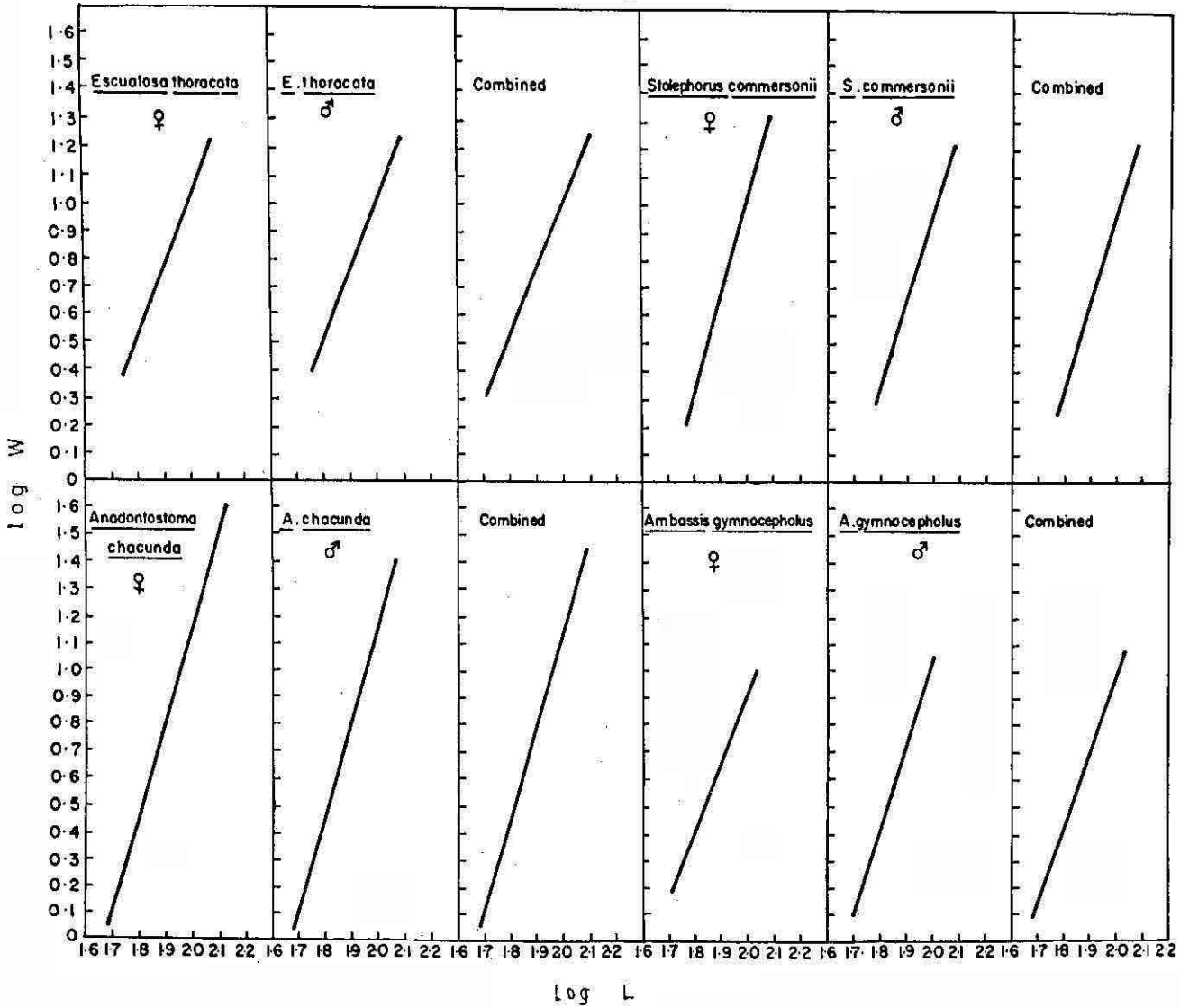

Escualosa thoracata
♀
E. thoracata
♂
Combined
Stolephorus commersonii
♀
S. commersonii
♂
Combined
Anadontostoma chacunda
♀
A. chacunda
♂
Combined
Ambassis gymnocephalus
♀
A. gymnocephalus
♂
Combined
log W
log L
1·6 1·5 1·4 1·3 1·2 1·1 1·0 0·9 0·8 0·7 0·6 0·5 0·4 0·3 0·2 0·1 0
1·6 1·7 1·8 1·9 2·0 2·1 2·2

Fig. 8

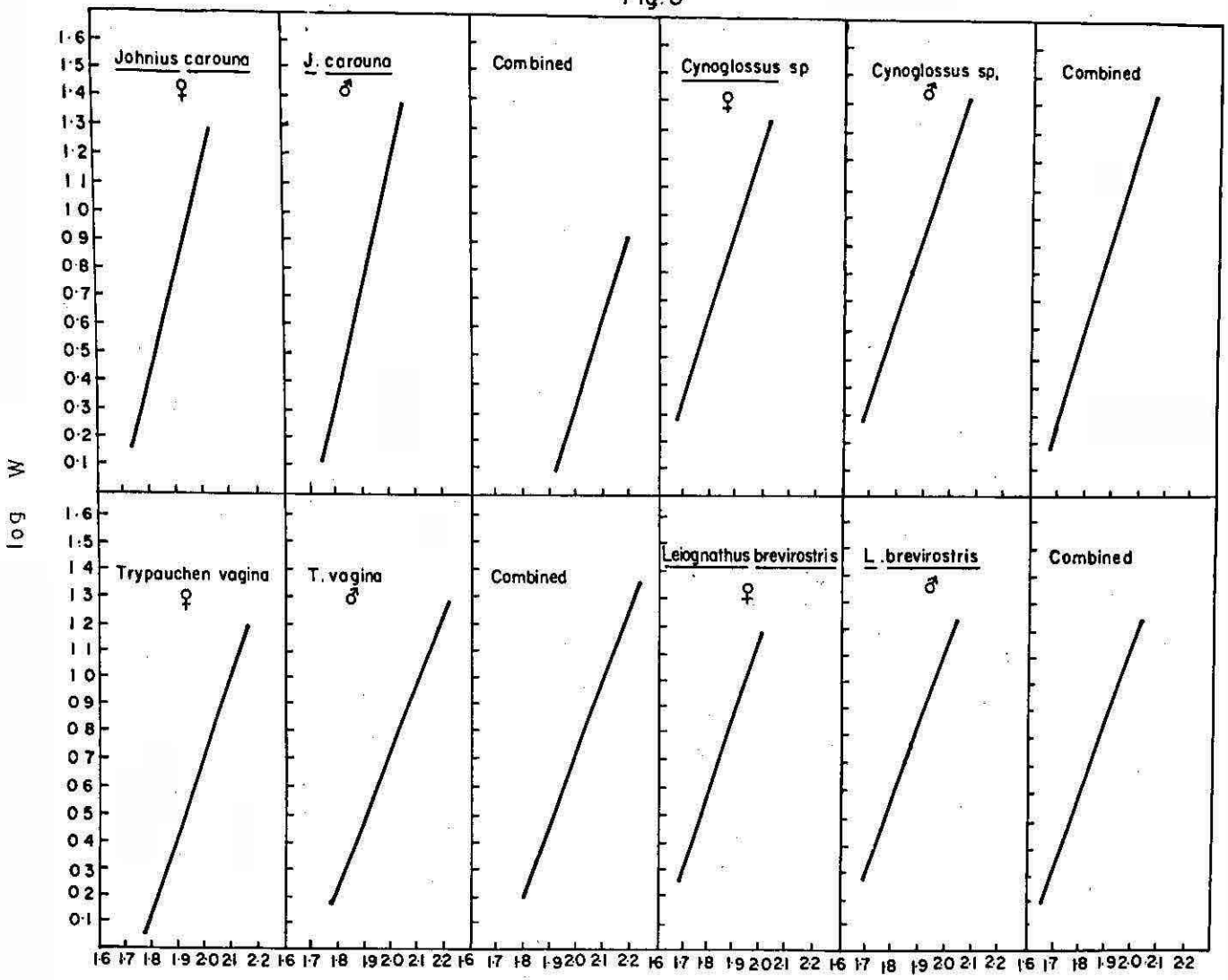
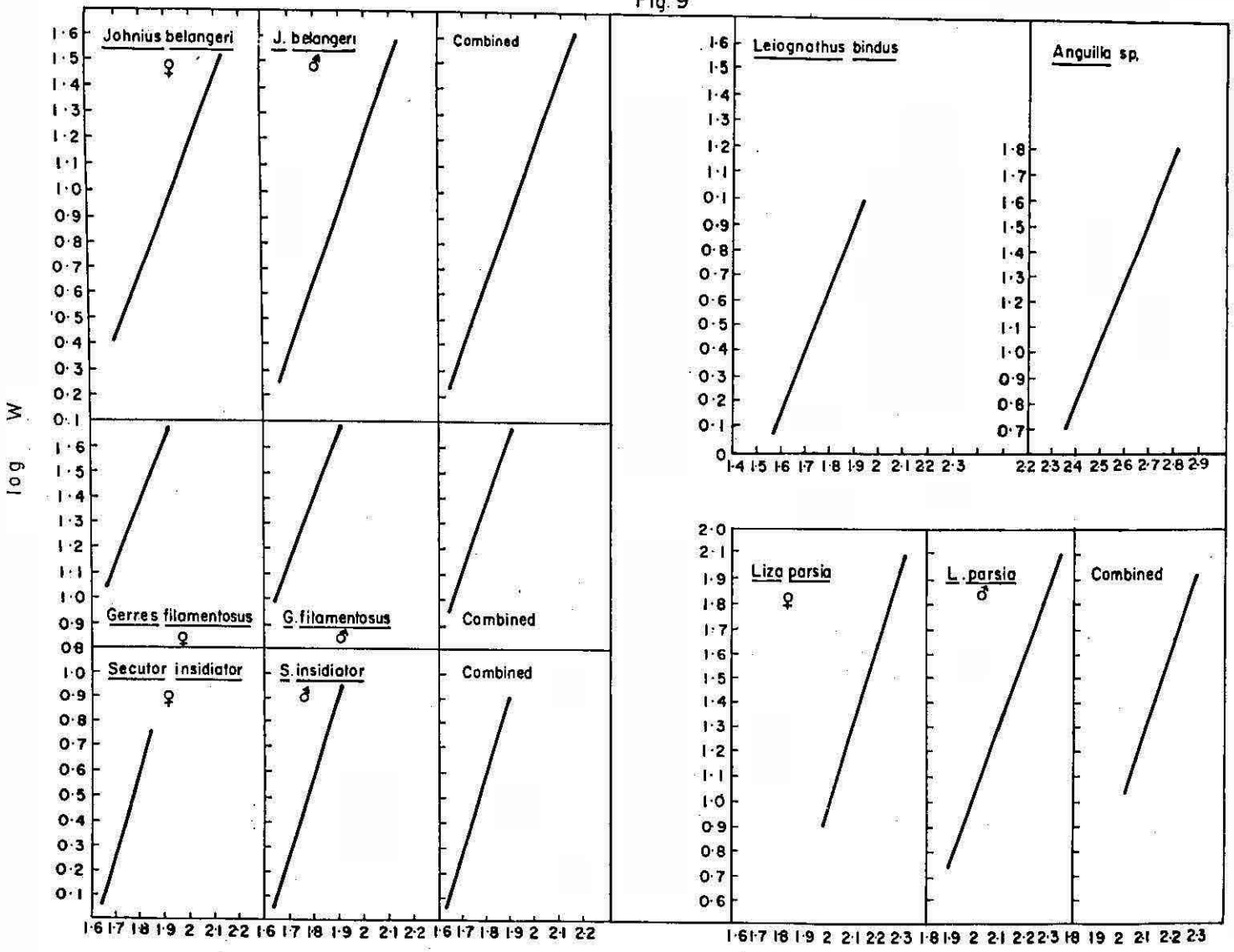

Johnius carouna ♀
J. carouna ♂
Combined
Cynoglossus sp ♀
Cynoglossus sp. ♂
Combined
Trypauchen vagina ♀
T. vagina ♂
Combined
Leiognathus brevirostris ♀
L. brevirostris ♂
Combined
log W
log L

Fig. 9


Johnius belangeri ♀
J. belangeri ♂
Combined
Gerres filamentosus ♀
G. filamentosus ♂
Combined
Secutor insidiator ♀
S. insidiator ♂
Combined
Leiognathus bindus
Anguilla sp.
Liza parsia ♀
L. parsia ♂
Combined
log W
log L

4. Anguilla sp. (Fig. 9)

log W = -5.9848 + 2.7849 x log L

r = 0.4586

5. Liza parsia (Fig. 9)

Female log W = -5.5308 + 3.2452 x log L

r = 0.9527

Male log W = -4.4268 + 2.7380 log L

r = 0.8764

Combined log W = -5.1603 + 3.0773 log L

r = 0.9359

6. Ambassis gymnocephalus (Fig. 7)

Female log W = -5.1046 + 3.0612 x log L

r = 0.8947

Male log W = -3.9345 + 2.4106 x log L

r = 0.8137

Combined log W = -4.5572 + 2.7563 log L

r = 0.8549

7. Gerres filamentosus (Fig. 9)

Female log W = -3.4909 + 2.7148 x log L

r = 0.7203

Male log	W	=	-3.5744 + 2.7651 x log L
	r	=	0.7091
Combined log	W	=	-3.5104 + 2.7316 x log L
	r	=	0.7114

8. Secutor insidiator (Fig. 9)

Female log	W	=	-5.0032 + 3.1055 x log L
	r	=	0.8646
Male log	W	=	-4.9862 + 3.0966 x log L
	r	=	0.9033
Combined log	W	=	-4.9883 + 3.0793 x log L
	r	=	0.8897

9. Leiognathus bindus (Fig. 9)

Combined log	W	=	-3.7922 + 2.4685 x log L
	r	=	0.9491

10. Leiognathus brevirostris (Fig. 8)

Female log	W	=	-4.4728 + 2.7973 x log L
	r	=	0.8953
Male log	W	=	-4.5484 + 2.8446 x log L
	r	=	0.8689

Combined log	W	=	-4.5710 + 2.8525 x log L
	r	=	0.8845

11. Johnius belangeri (Fig. 9)

Female log	W	=	-3.8316 + 2.5033 x log L
	r	=	0.8435
Male log	W	=	-4.2698 + 2.7285 x log L
	r	=	0.8865
Combined log	W	=	-4.1027 + 2.6409 x log L
	r	=	0.8715

12. Johnius carouna (Fig. 8)

Female log	W	=	-6.7134 + 3.9254 x log L
	r	=	0.8233
Male log	W	=	-3.9923 + 2.5065 x log L
	r	=	0.7481
Combined log	W	=	-5.7229 + 3.0133 x log L
	r	=	0.7669

13. Trypauchen vagina (Fig. 8)

Female log	W	=	-5.0815 + 2
	r	=	0.9999

Male log	W	=	-4.0654 + 2.3964 x log L
	r	=	0.8720
Combined log	W	=	-4.5512 + 2.6261 x log L
	r	=	0.9093

14. Cynoglossus sp. (Fig. 8)

Female log	W	=	-4.9194 + 3.0816 x log L
	r	=	0.9880
Male log	W	=	-4.5972 + 2.9111 x log L
	r	=	0.9671
Combined log	W	=	-4.8747 + 3.0583 x log L
	r	=	0.9850

4.8. Sex ratio

The sexes were separated in each and the ratio fou out as listed below. In most of the species the two sexes were almost equal in proportion. But in Johnius carouna the male : female ratio was almost 2 : 1, whereas in Liza parsia and Cynoglossus sp. vice versa.

	Species	Male	Female
1.	Escualosa thoracata	47.6%	52.4%
2.	Stolephorus commersonii	41.1%	55.9%
3.	Johnius belangeri	45.6%	54.4%
4.	Johnius carouna	64.6%	35.4%
5.	Secutor insidiator	40.8%	59.2%
6.	Leiognathus brevirostris	47.8%	52.2%
7.	Cynoglossus sp.	33.3%	66.7%
8.	Liza parsia	33.3%	66.7%
9.	Anadontostoma chacunda	50.8%	49.2%
10.	Trypauchen vagina	48.3%	51.7%
11.	Ambassis gymnocephalus	56.0%	44.0%
12.	Gerres filamentosus	47.1%	52.9%

4.9. Stomach content

The gut content analyses of a number of fishes which were abundant during the study was conducted. the result of which are as follows:

Fifty fishes of Escualosa thoracata were analysed. The species, according to this study, is a plankton feeder feeding mainly on copepods. Lucifer and Sagitta were found in lesser numbers. Phytoplankton like Biddulphia and

Coscinodiscus were also present. Similarly, fifty fishes of Anadontostoma chacunda were analysed for their stomach contents and phytoplankton like Coscinodiscus, Biddulphia, Pleurosigma and zooplankton like copepods were relatively abundant. Other crustaceans like Lucifer and amphipods were present in negligible numbers. Decapods mainly prawns constituted the major portion of the gut contents of Stolephorus commersonii. Lucifer, copepods and amphipods also were found in good numbers. Polychaetes, molluscs and phytoplankton, Pleurosigma were present in lesser quantities.

The major constituents in cat fish stomachs were crustaceans mainly squlla, prawn, amphipods and alima larvae. Crustacean remains were also found in good quantity. Polychaetes and molluscs were present in lesser numbers. Algal matter and sand particles were present along with the food. In Liza parsia the important food item found was copepod and in Ambassis gymnocephalus rotifer, copepods, amphipods and Lucifer dominated. Phytoplankton like Biddulphia and Coscinodiscus were found in lesser numbers. In few specimens sand particles and semidigested matter were also present. In the stomach of Leiognathus brevirostris the food items were mainly polychaetes, mollusc and copepods. As in the case of A. gymnocephalus sand particles also were found. In all the stomachs of Trypauchen vagina examined, the major constituents

were benthic organisms, mainly polychaetes. Undigested matter along with sand particles was present in equal amounts. In the stomachs of Johnius the contents revealed the presence of fish ramains which were relatively abundant. Crustaceans were less, consisting mainly Acetes and Squilla. The stomach contents of Sillago sihama showed the species to feed mainly on mysids, lucifers, copepods and polychaetes. In some specimens crustacean remains were observed in relatively good quantities. Cynoglossus sp. subsists mainly on polychaetes. Molluscs and amphipods were present in lesser numbers. Sand particles were also present.

5. DISCUSSION

The Cochin Backwater has been recognised as a good nursery ground for a large number of commercially important fishes and prawns. Working on the ichthyoplankton of Cochin Backwater, Rengarajan and David Raj (1979) observed the place to contain the larvae of 19 groups of fishes. This backwater is equally important as a rich ground for the fishery of both finfishes and prawns, as evidenced from their respective contribution of 54% and 46% to the total catch estimated during the present study.

Fiftyeight species of fishes were recorded from the backwaters at Cochin during the present period under review here. Out of these, 47 were already reported by Kurup and Samuel (1980, 1983 and 1985), and Kathirvel and Daniel Selvaraj (1980). The 11 species not listed in their papers are Pellona sp., Holocentrus rubrum, Eutherapon theraps, Lactarius lactarius, Johnius carouna, Siganus oramin, Ctenochaetus strigosus, Trichiurus sp., Rastrelliger kanagurta, Cybium guttatum, and Pampus argenteus.

5.1. Specieswise Analysis

The prawns, as already mentioned form 46% of the landings in the backwaters and s[illegible]ke nets at Thevara and Thoppumpady

get most of it (Fig. 2). The drag nets at Pachalam also get it abundantly in excess to the finfish (Fig. 2). The most abundant item among the prawns is 'Thelly', the juveniles of Metapenaeus dobsoni. Stake nets thus catch very small prawns and caridean prawn, Acetes indicus also figures well in the landings occasionally during the monsoon months.

Next to prawns Ambassis dominates in the catches, with the species A. gymnocephalus as the abundant form. A. dayi occurred during the monsoon months especially at Pachalam where the freshwater influence from Periyar is prominent. Munro (1982) qualifies this species as a freshwater form and Kurup and Samuel (1985) report it as the most common resident one among Ambassis spp. in Vembanad Lake all through the year.

Stolephorus commersonii is another major species abundant in the catches especially of the stake nets and dip nets. The highest catch of this species appeared in April at Thevara forming 18.5% of finfish catch. In the dip nets at Vypeen in the barmouth in May it accounted for 26.3% and at Fort Cochin 22.6%. It being rare and small in quantity in monsoon months, this species appears to prefer more saline waters. Kurup and Samuel (1985) also reported it to be a migrant form rare during rainy season.

Silverbellies

Kurup and Samuel (1983) reported on the occurrence of 9 species in the Vembanad Lake. Of these only 4 as mentioned in the results are obtained in the Cochin Backwater during the present study. Silverbellies were caught in good quantities in stake nets especially at Thevara. The length studies show the silverbellies to be fast growing fishes that are continuously being recruited into the fishery (Fig. 6).

Though Kurup and Samuel (1985) report the occurrence of sciaenids in the lake as rare, they were found in good quantities in the Cochin area in all the months under observation where big sized specimens (Table 3) were caught as a fishery.

Etroplus spp.

Etroplus spp. are common in the catches at Cochin Backwater area also as in the Vembanad Lake where Kurup and Samuel (1985) observed them to have been caught in all the months of the year. Though this fish forms a good constituent in the stake net catches, it is more important in the drag net landings at Pachalam where it occurs for a longer period. Etroplus suratensis is a prized table fish and hence is in good demand. The fish caught however, are only of medium sizes (Table 3) with a mode at 95 mm.

Kurup and Samuel (1985) cited the cat fish, Tachysurus maculatus as a resident fish occurring in Vembanad Lake through out the year. Munro (1982) qualifies it as a species that occurs in estuarine and tidal rivers and indicates that it could attain a size of 350 mm. The species was available in the Cochin Backwater all through the present period of study. But widely separated size ranges were obtained in the length distribution.

New recruitment commences from 100 mm size occurred in the fishery in April-June. In July-September big fishes of size range 175-200 mm were found. The period of occurrence of big ones coincides with the monsoon months. The stomach contents of the fish after monsoon showed the presence of alima larva probably indicating T. maculatus to be a marine fish entering the estuarine area.

Trypauchen vagina was landed mainly by the stake net units. It contributes to the fishery in considerable quantities amounting to 2189 kg forming 8% of the total finfish catch at Thevara and 2467 kg forming 12% at Thoppumpady. The highest monthly catch of 798 kg accounting for 21% of the month's fish catch occurred at Thevara in August. In the dip nets the catch was less, but in drag nets and drift nets this species was absent, indicating its preference for more saline waters. Kurup and Samuel (1985) reported it to

be a migrant species occurring in the Vembanad lake in June-November period. It occurred in April-September during the present investigation.

At present Trypauchen has no commercial value, and hence discarded without being included in trash fish. A small portion of its catch, however, is being utilized as a feed for ducks.

The length distribution showed good growth curve. It is obvious from this that new recruitment takes place in September with size ranging from 25-40 mm. However, fishes from at least 3 broods may be entering the fishery in other months. But the smaller ones escape capture by the net through the mesh when the general fishery is poor and the catches are thin, consequently reducing the crowding at the cod end.

Cynoglossus sp. has been reported to be a resident species (Kurup and Samuel, 1985). But this species was found absent in the Chinese dip net catches from April to July. But in other gears, except drift net it was present. At Thevara in stake net the catches were so high as 2645 kg in total during the period of observation at present.

Small ones varying in size from 21 to 34 mm were caught by stake nets in August.

Carangids also were caught mostly by stake nets. The species that were caught are Caranx sexfasciatus and C. malabaricus. The former was the most common one. Kurup and Samuel (1985) have reported it to be a resident species occurring in all the months. C. malabaricus was caught in lesser numbers during the study. This species is not recorded by the previous workers.

Liza spp. is a commercially important fish. Kurup and Samuel (1985) reported Liza spp. as resident species very commonly occuring in all the months. During the present study Liza parsia was obtained from May to October. In the drag net catches at Pachalam in October it formed 650 kg (20%). In the dip nets also this species constituted high percentage ranging from 12% to 29% at Vypeen and 6% to 21% at Fort Cochin. In the drift nets and stake nets the catch of this species is less. Liza macrolepis occurred in stray numbers in the catches. The length distribution showed wide ranges.

Gerres spp. yet another commercially important group, constitute an important fishery in the backwaters especially in the drift net. G. filamentosus and G. oyena are the only two species obtained during the study. The former is a resident form occurring in all the months (Kurup and Samuel, 1985). The

same authors have recorded 2 more species, G. abbreviatus and G. setifer. At Vypeen and Fort Cochin (dip nets) and Thevara and Thoppumpady (stake nets) Gerres spp. figured well.

In June, at Pachalam; though the catch was less, its percentage in the finfish was high.

Sillago sihama is of great importance as a priced fish and also as a culturable one. According to Kurup and Samuel (1985) Sillago sp. is a resident form. The catch of this fish is more, forming about 14% and 6% of the finfish catch. In stake nets it did not occur.

Hemiramphus sp. was caught only at Pachalam. It is of interest that during monsoon months also this species was present. In June and July it formed about 4-7%. This reveals that this fish can tolerate even lesser salinity condition.

Under Thryssa spp., T. setirostris and T. mystax are the two species obtained during the study. Kurup and Samuel (1985) recorded the occurrence of 2 more species, T. purava and T. kammalensis. According to their reports T. setirostris is a migrant, rarely occurring species, present in the lake during March-April and I. mystax is also a migrant form commonly occurring in September-May.

Kurup and Samuel (1985) have recorded the occurrence of Platycephalus crocodilus as a resident species in all months in the lake. During the present study it occurred only at Pachalam in drag nets and drift nets from July to September. Its percentage was more in July-August, in the drift nets. In October a single large specimen 234 mm long was caught by a stake net unit at Thevara. It did not occur in the catches at the other centres. This reveals that this species prefers fresh water condition.

Escualosa thoracata is a migrant fish occurring in the backwaters in September-May (Kurup and Samuel, 1985). But during the present investigation this species was absent from February to July and in September in the drag nets catches. At Thoppumpady this was caught only in June. At Thevara, Vypeen and Fort Cochin this species did not occur.

Ehirava fluviatilis is included in the Sub-family Pellonulinae (Pisces: Clupeidae) by Kurup and Samuel in 1980. In the present study this species is included in the Family Dummumeiridae following the classification by Munro (1982). This species occurred in the stake nets at Thoppumpady in October and it was absent at all other centres. In the Cochin area Kurup and Samuel (1980) reported it to occur in February-May period.

Anadontostoma chacunda is a common migrant fish. During the period of study this fish occurred in June, July and August as against September-June given by Kurup and Samuel (1985).

Eel, Anguilla sp. occurred only in the stake net catches in September-October. According to the reports by Kurup and Samuel (1985) Anguilla is a resident species present all through the year. In the dip nets, drag nets and drift nets this did not occur.

Mugil cephalus is a resident species present in Vembanad Lake through out the year (Kurup and Samuel, 1985). In the present study this species occurred as a fishery only in the dip net catches in September. Big fishes of sizes 300-400 mm with mode at 350 mm constituted this fishery. Younger specimens varying in size from 43-54 mm were caught in the same gear in monsoon months. M. cephalus is the costliest of the fish produced in the fishery of backwaters. The dip net units spread over the entire area including adjacent places in the lake depend very much on the availability of this fish for economic success. A fish of about 400 mm would easily fetch around Rs.100/- and the fishermen wind up a days operation if they get 3 or 4 fish in the first few operation itself.

According to the report by Kurup and Samuel (1985) Synaptura sp. is a vagrant one occurring in the lake during March-April. But in the present investigation it occurred in the trawl net and stake net catches in June.

Triacanthus sp. according to Kurup and Samuel (1985) occur during September-May. But presently it appeared in the backwater in July during rainy season.

Lactarius lactarius was found in good numbers in the experimental trawl catches in shipping channel. In the commercial catches of the conventional gears used for fishing in the backwaters, this fish was absent except in October in the dip net at Fort Cochin by the side of shipping channel. The sizes of the fish caught in the backwater, however, are small ranging between 60 and 80 mm and they being stray occurrences did not exhibit any mode. The species is a purely marine form found in coastal waters and trawling grounds and is reported to grow to 280 mm in size (Munro, 1982). Kurup and Samuel (1985) did not report this fish from the Vembanad Lake.

Pampus argenteus is also a marine species prevalent in coastal waters and is said to grow to 300 mm in size (Munro, 1982). But it was caught in June in the stake nets at Thevara when freshwater influence was more. The quantity

caught here amounted to 57 kg forming 1.7% of the month's finfish catch at the centre. Contrary to the marine fishery, the sizes of the species caught here were between 88 and 131 mm only. Occurrence of the pomfret in the lake was not reported by Kurup and Samuel (1985).

Similar occurrences of the young ones of other purely marine species like the Indian mackerel, Rastrelliger kanagurta; Indian oil sardine, Sardinella longiceps; ribbon fish, Trichiurus sp.; seer fish, Cybium guttatum; the shad, Pellona sp.; and the rabbit fish, Siganus oramin in the Cochin Backwaters is available in the present study. None of these were reported by Kurup and Samuel (1985).

An unusual fishery on commercial sizes of mackerel in the Cochin Backwater during summer months was reported by George (1965) and of small-sized ones during monsoon season by Noble (1974). Migration of juvenile oil sardine into the backwater likewise was reported by Reghu (1973). Kurup and Samuel (1985) included Siganus javus, S. lineatus and S. canaliculatus in the list of fish occurring in the lake. In the present study yet another species viz. S. oramin of size range 62-74 with mode at 65 mm strayed into the catch by stake net at Thevara in March. Trichiurus sp. was caught in the stake nets at Thevara and Thoppumpady during June-July. Being a marine species, this appears to enter the backwaters

through the shipping channel along with the current during high tide and move down south into the stake nets installed on both sides of Wellington Island.

Pellona sp. of size 61-78 mm were found in the experimental trawling in shipping channel in September and stake nets at Thevara in May. The juveniles of Cybium guttatum of size 75 and 106-117 mm were caught in May at Thevara in stake nets.

While 4 specimens of Holocentrus rubrum measuring 100, 113, 116 and 118 mm in total length were caught in the stake net on a day in October. Only a single specimen of Ctenochaetus strigosus of 94 mm total length was caught at Vypeen in Chinese dip net. Kurup and Samuel (1985) reported another species namely Acanthurus matoides of the family Acanthuridae and puts it as a migrant species occurring rarely during February-April. Johnius carouna occurred in good quantities in the landings of sciaenids (Fig. 4) and they ranged in size between 56 and 101 mm with mode at 85 mm (Table 3).

Eutherapon theraps, an estuarine species (Munro, 1982) was present in the stake net catches at Thevara in September and October. The species reported by Kurup and Samuel (1985) was Therapon jarbua.

5.2. Centrewise analysis

Out of the centres observed, maximum production was at Thevara (Fig. 2). Thoppumpady stands next to it. While there were good landing by the drag net at Pachalam in the 4 months during summer season, it fell drastically in the monsoon months (Fig. 2), practically becoming nil in most of the days. This fall was not only due to the scarcity of the fish, other than Etroplus suratensis (Fig. 5), but also due to slackening in the effort put in. The reduction in effort during rainy season is visible at other places also. For instance, out of around 100 stake nets each at Thevara and Thoppumpady only 70 to 80 numbers were operated.

Chinese dip net operation depends on the favourable tidal flow during high tide when waves splash on the banks of the backwaters. The effect of the tidal inflow is first experienced at Fort Cochin and then at Vypeen, where it hits about 30 to 45 minutes later, with the result that the fishing always commences early at the former than at the latter place. Fort Cochin, it is observed, is more at an advantageous position in topography as to help the tidal flow to hit it first than the Vypeen side. The dip net operation therefore lasts for a longer period at Fort Cochin. Despite this fact, the total fish production is found to be more at Vypeen (Fig. 2). The prawn landing too was more at this centre (Fig. 3).

In the variety of fish caught in the Cochin Backwater also Vypeen tops with Thevara following.

Quantitywise as already mentioned above, Thevara excells other places. The shipping channel in the backwater takes a smooth bend on the north east corner of the Wellington Island and extends to the Naval and Shipyard warfs. Thevara lying almost in straight line to this channel probably gets a free flow of water from the sea during high tide taking more fish towards south along the eastern side of the Island. Thoppumpady lying on the western side of the Island is disadvantaged to a large extent as the shipping channel towards it is only a side cut of the main channel. Absence of shipping channel on the northern side of the backwater may be likewise causing less transport of fish towards that area and consequent comparatively poor production at Pachalam.

5.3. Length distribution and length-weight relationship

Length-weight relationship on Gerres filamentosus, Liza parsia and Nibea albida occurring in Cochin estuary were done by Kurup (1982). Excluding N. albida the length-weight relation of these fishes were done in the current study. Kurup found the relation separately for indeterminates, males and females on L. parsia and observed the 'b' values to differ significantly at 5% level. Except between indeterminates

and females 'b' values were not significant at 5%. In the present study there was no significant difference between males and females in F test.

Studies on length distribution of the fish in the catches reveal that most of them are fast growing forms and are periodically being fed into the biota through recruitment. The slope in the length-weight relationship also indicates most of them to be gaining weight at faster rate probably suggesting forms like Anadontostoma chacunda, Liza parsia, Stolephorus commersonii, Secutor insidiator, and Cynoglossus sp. for culture in eco-systems. In the case of Johnius carouna the females gain weight much faster than the males. In L. parsia and A. gymnocephalus also the females exhibit fast gain in weight than males. The difference shown in the length-weight relationship between male and female was significant at 1% level in S. commersonii and at 5% level in J. carouna in slopes.

Suggestions

As evident from the present investigation, the Cochin Backwater has a rich finfish and shellfish resource, and these backwaters form the nursery ground for a number of prawns and fishes of commercial value. Species, which can fetch good prices in the market like, Mugil cephalus, Liza parsia,

Etroplus suratensis and Sillago sihama can be used for culture. At present the undersized ones caught in the commercial gears are discarded, without being put to any use.

A step to be taken in this context is the proper management measures regarding the mesh sizes of the different gears. Though the stake nets are licenced, these nets catch even very small sized fishes and prawns causing waste in the resource and fishery. This leads to the situation where the fishes are caught before attaining maturity and are not given sufficient period to grow to an optimum size when they are ready to be caught.

The fishes fetch good price in the local markets. But the landings include fishes like Trypauchen, eel, and Trichiurus not included even in the group of trash fish. They are simply thrown away and is not put to any use. It has been observed that to a small extent Trypauchen sp. is used as a feed for ducks. Trypauchen vagina, Johnius carouna, Stolephorus commersonii and Cynoglossus sp. are fast growing and fast weight gaining fishes which can be inducted into the culture systems not suitable for culture of quality fishes. From the present investigation it was brought to the notice that instead of being wasted these fishes can be given as a poultry feed, fish manure, a feed in culture or can even be

converted into consumable products like soups, protein concentrates, fish powder etc.

This study reveals the potential of the Cochin Backwater towards diversification in the selection of fishes for culture practices. Proper seed procuring techniques have to be developed in order to utilize this rich seed resources of the backwaters. This is of utmost importance as culture is gaining more popularity in the low lying areas adjacent to the backwaters.

6. SUMMARY

1. An investigation on the fish and fisheries of Cochin Backwater was conducted during a period of 9 months from February to October. Periodic observations were carried out at different centres like Pachalam, Vypeen, Fort Cochin, Thoppumpady and Thevara. Fortnightly, experimental trawling was conducted to know the species composition. Cast net operations also were observed for the same purpose.

2. The study revealed that prawns form a major part of the total landings except in the dip nets and drift nets.

3. Among finfish, Ambassis gymnocephalus, Stolephorus commersonii, Leiognathus brevirostris, L. bindus, Johnius balangeri, J. carouna, Etroplus suratensis, Tachysurus maculatus, Trypauchen vagina, Cynoglossus sp., Liza parsia, Gerres filamentosus, G. oyena and Sillago sihama, figured well in the catches by the different gears employed.

4. Fishes like Mugil cephalus, Liza parsia, Etroplus suratensis, Sillago sihama, Anadontostoma chacunda, and Gerres filamentosus fetch very high prices in the markets.

5. Fishes which constituted a minor fishery were Escualosa thoracata, Ehirava fluviatilis, Anadontostoma chacunda, Eleutheronema tetradactylum, Eutherapon theraps, Lactarius

lactarius, Sorotherodon mossambica, Pampus argenteus, Austrobatrachus dussumeiri, Chanos chanos, Hemiramphus sp. and Strongylura strongylura.

6. Purely marine species that were caught during the present investigation are Rastrelliger kanagurta, Sardinella longiceps, Pampus argenteus, Trichiurus sp., Cybium guttatum, Pellona sp., Siganus oramin, Holocentrus rubrum, Ctenochaetus strigosus, Lactarius lactarius, and Scatophagus argus occurred in stray numbers. Other stray items were Elops saurus, Megalops cyprinoides, Tetradon sp., Triacanthus sp., Lutianus argentimaculatus and Epinepheles.

7. Fishes like Trypauchen vagina, Anguilla sp. and Trichiurus sp. are not put to any use at present. In the case of the former, a small percentage is being utilized as a feed for ducks.

8. Studies on length distribution reveal that most of the important species of fish occurring in the backwaters are fast growing forms and they are periodically being recruited into the fishery.

9. The length-weight relationship indicates most of them to gain weight at a faster rate, which points to the prospects for their culture.

10. The stomach content analysis revealed the feeding habits of different species. Johnius spp., Cynoglossus sp., Leiognathus brevirostris, and Trypauchen vagina feed mainly on the benthic organisms. Escualosa thoracata, Anadontostoma chacunda, Stolephorus commersonii, Liza parsia, Ambassis gymnocephalus and Sillago sihama feed mostly on the planktonic organisms.

11. Young ones of the fishes and prawns present in the backwaters are indiscriminately exploited causing waste of the resource potential. Proper management measures have to be taken to control this and many of such small fishes can be used for culture.

REFERENCES

BALAKRISHNAN, A. 1957. Variations in salinity and temperature in Ernakulam channel. Bull. Cent. Res. Univ. Kerala, 5, 7-9.

CHERIYAN, P.V. 1967. Hydrological studies in and around Cochin harbour. Bull. Dept. mar. biol. Oceanogr. Univ. Kerala, 3: 9-17.

HARIDAS, P., M. MADHUPRATAP and T.S.S. RAO 1973. Salinity, temperature, Oxygen and zooplankton biomass of the backwaters from Cochin to Alleppey. Indian. J. mar. Sci., 2: 94-102.

GEORGE, K.C. 1965. On an unusual fishery for the mackerel in the Cochin Backwaters. J. mar. biol. Ass. India, 7 (1): 219-222.

GEORGE, M.J. 1961. Studies on the prawn fishery of Cochin and Alleppey coast. Indian. J. Fish., 8 (1) :75-95.

GEORGE, M.J. 1963. Post larval abundance as a possible index of fishing success in the prawn Metapenaeus dobsoni (Miers). Indian. J. Fish., 10 (1): 135-139.

GEORGE, M.J. and K.N.K. KARTHA 1963. Surface salinity of Cochin backwater with reference to tide. J. mar. biol. Ass. India, 5 (2): 178-184.

GOPINATHAN, C.K. and S.Z. QASIM 1971. Silting in navigational channels of the Cochin Harbour area. J. mar. biol. Ass. India, 13 (1): 14-26.

JOSANTO, V. 1971. The bottom salinity characteristics and factors that influence the salt water penetration in the Vembanad Lake. Bull. Dept. mar. biol. Oceanogr., 5: 1-16.

KATHIRVEL, M. and G.S.D. SELVARAJ 1980. Notes on the juveniles of the rock cod Epinephelus tauvina (Forskal). J. mar. biol. Ass. India, 22 (1&2): 173-174.

KURUP, M.B. 1982. Studies on the systematics and biology of the fishes of the Vembanad Lake. Ph.D. Thesis, Univ. Cochin, pp. 683.

RAMAMIRTHAM, C.P., S. MUTHUSAMY and L.R. KHAMBADKAR 1986. Estuarine oceanography of Vembanad Lake. Part I. The region between Pallipular (Vaikom) and Thevara (Cochin). Indian J. Fish., 33(1): 85-93.

RAMAMIRTHAM, C.P. and S. MUTHUSAMY 1986. Estuarine oceanography of Vembanad Lake. Part II. The region between Cochin and Azhikode. Indian J. Fish., 33(2): 218-224.

RASALAM, E.J. and M.J. SEBASTIAN 1976. The lime shell fisheries of the Vembanad Lake, Kerala. J. mar. biol. Ass., 18(2): 323-355.

REGHU, R. 1973. Migration of the juvenile of oil sardine, Sardinella longiceps (Val) into the backwaters of Cochin. Indian J. Fish., 20(2): 655-657.

RENGARAJAN, K. and I. DAVID RAJ 1979. On icthyoplankton of the Cochin Backwaters during spring tides. J. mar. biol. Ass. India, 21(1 & 2): 111-118.

SAMUEL, C.T. 1969. Probelms and prospects of the estuarine fisheries of Kerala. First All India Symposium in Estuarine Biology, Tambaram, Madras.

SHETTY, H.P.C. 1963. A preliminary fishery survey of the Vembanad backwaters, Kerala, Surv. Rep. Cent. Inl. Fish. Res. Inst., 2: pp. 24.

SHETTY, H.P.C. 1965. Observations on the fish and fisheries of Vembanad backwaters, Kerala. Proc. Natn. Acad. Sci. India, 35B, 115-130.

SILAS, E.G., M.J. GEORGE and T. JACOB 1981. A review of shrimp fisheries of India. A scientific basis for the Management of Penaeid Shrimp. Workshop on the scientific basis for the Management of Penaeid shrimp. Key West, Florida, U.S.A.

SNEDECOR, G.W. and W.G. COCHRAN 1967. Statistical methods. 6th ed. Iowa State. Univ. Press, Okla., Norman pp. 120.

SREEDHARAN, MANIKOTH and MOHAMED SALIH 1974. Distribution characteristics of nutrients in the estuarine complex of Cochin, Indian. J. mar. Sci., 3: 125-130.

SUSEELAN, C. and M. KATHIRVEL 1982. Prawn seed calenders of Cochin backwaters. Proc. Symp. Coastal Aquaculture, I: 173-182.

TAMPI, P.R.S. 1973. Culturable marine fish fry resources from brackishwater environments. Proc. Symp. Living Resources of Seas Around India, Special Publication, CMFRI, pp. 241-257

KURUP, M.B. and C.T. SAMUEL 1980. Fishes of the subfamily Pellonulinae (Pisces: Clupeidae) from Vembanad Lake, Kerala, South India.

KURUP, M.B. and C.T. SAMUEL 1983a. Systematics and distribution of fishes of the Family Leiognathidae (Pisces) the Vembanad Lake, Kerala (S. India). Rec. Zool. Surv. India, 80: 387-411.

KURUP, M.B. and C.T. SAMUEL 1985. Fish and fishery resources of Vembanad Lake. Harvest and post harvest Technology of Fish. Soc. Fish. Tech, 77-82.

KUTTYAMMA, V.J. 1975. Studies on the relative abundance and seasonal variation in the occurrence of post larvae of three species of penaeid prawns in Cochin backwater. Bull. Dept. mar. Sci. Univ. Cochin, 1 (1): 213-219.

MOHAMED, K.H. and P. VEDAVYASA RAO 1971. Estuarine phase in the life history of the commercial prawns of the West Coast of India. J. mar. biol. Assn. India, 13(2): 149-161.

MUNRO, I.S.R. 1982. The marine and freshwater fishes of Ceylon. Soni reprints agency, Delhi.

NAIR, K.K.C. and D.J. TRANTER 1971. Zooplankton distribution along salinity gradient in the Cochin backwaters before and after the monsoon. J. mar. biol. Ass. India, 13: 203 - 210.

NOBLE, A. 1974. Entry of the small sized mackerel Rastrelliger kanagurta (Cuvier) into the Cochin backwaters during the monsoon season. Indian J. Fish., 21: 292-294.

PILLAI, N.N. 1973. Larval development and rearing of the Brackishwater shrimp Leptocarpus potamiscus (Kemp, 1917) (Decapoda, Palaemonidae). J. mar. biol. Ass. India, 15(2): 669-684.

QASIM, S.Z. and C.P. GOPINATHAN 1969. Tidal cycle and the environmental features of Cochin backwaters. Proc. Ind. Acad. Sci., 69(6): 336-348.

RAMAMIRTHAM, C.P. and R. JAYARAMAN 1963. Some aspects of the hydrobiological conditions of backwaters around Wellington Island (Cochin). J. mar. biol. Ass. India, 5(2): 170-177.